OBJECT LESSONS

IN

ELEMENTARY SCIENCE

AND

GEOGRAPHY

COMBINED

VOL. II STANDARD II

VINCENT T. MURCHÉ

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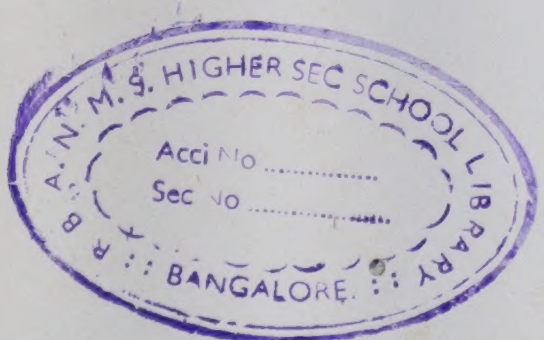

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THE

TEACHERS' MANUAL OF OBJECT LESSONS

IN

ELEMENTARY SCIENCE

AND

GEOGRAPHY COMBINED

A COMPLETE SCHEME

By VINCENT T. MURCHÉ, F.R.G.S.

HEAD MASTER OF BOUNDARY LANE BOARD SCHOOL, CAMBERWELL

AUTHOR OF OBJECT LESSONS IN ELEMENTARY SCIENCE; OBJECT LESSONS IN DOMESTIC ECONOMY; OBJECT LESSONS FOR INFANTS; SCIENCE READERS; DOMESTIC SCIENCE READERS, ETC.

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PREFACE

THERE was "a good time coming" for the children, when the Education Department wisely determined to discourage, through H.M. Inspectors, the senseless repetition of lists of names and meaningless definitions, and in its place to foster the cultivation of intelligent teaching by the natural process of observation; and under the new regime there is every prospect that our little ones will now be educated in the best meaning of the word.

Surely every teacher in the land will agree that in no subject of the school curriculum was the change so badly needed, as in the teaching of that all-important one—Geography—in its early stages.

This Scheme is intended primarily to carry out the requirements of the Code (1899) in the new Class subject, Elementary Science and Geography combined; but from its very composition, it will be found equally suitable, where geography alone is the goal ahead, and the teaching in Elementary Science will then naturally take its place in the ordinary Object Lesson Course of the school.

The Author has written with the Department's Circular open before him, and no point insisted on, or even advised in it, has been omitted.

Those lessons dealing with Common Objects and their properties provide an easy and natural series of stepping-stones, and the children are imperceptibly led by them,

and by their own observation of the simple every-day phenomena of earth, air, and water, to form clear and intelligent ideas of the world of wonders in which they live —and all this is done **without a single mention of the word geography itself.**

Throughout the three books the Scheme is arranged in two parts—the first part dealing with Elementary Science, the second with Geography. But it should be borne in mind that this is solely for the convenience of the books, and has no reference to the step-wise sequence of the lessons themselves.

It is suggested that in each stage the lessons on Common Objects be given first, because the various matters treated therein have been specially selected to pave the way for the teaching in the Second Part; and it should be noticed that this is also the plan of arrangement in the **Children's Readers, which will follow the Manuals immediately.**

A glance through the Table of Contents below will serve to show the aim and scope of the Scheme.

The child begins **by observation of the falling rain, the gutter streams, and roadside pools,** and these become his natural teachers, which help him to form intelligent ideas of the formation of rivers and lakes.

The rain and what becomes of it forms, indeed, the key-note of much of the future teaching. The rain feeds the rivers; the rivers feed the sea. The rain even prevents the sea itself from getting salter and salter day by day.

Then, by a natural sequence, after dwelling on the blessings of the rain, the teacher introduces, at the end of Stage II., the Rainless Desert.

Another point worthy of notice is that the map of England is introduced in sections by means of sand-models at the opening of Stage III., and the child passes naturally

to notice Scotland, the British Isles, and the mainland close by—and it is not till this stage is reached that **the name Continent** is mentioned.

The word Geography (earth-knowledge)—how it is learned—and its uses—**form a fitting close to the scheme,** when it is confidently felt that the child will be prepared to take up with zest and intelligence the study of some definite parts of the world—beginning, of course, with his own country.

Amongst other aims the Author has set himself the task of endeavouring to DO AWAY FOR EVER WITH THE RIDICULOUS AND ILLOGICAL PRACTICE OF DRAWING PLANS ON AN UPRIGHT BLACK-BOARD, than which nothing can be more confusing to the young mind.

The Manuals and Readers have been prepared in connection with the Author's New Modelling Tray, Geographical Models and Apparatus, which are published by Messrs. A. Brown and Sons, and are "on file" for Patent Rights in **the British Dominions, France, Germany,** and the **United States of America.**

The **coloured pictures of the Children's Readers** are being enlarged for the purposes of **Wall Pictures** for further illustration.

The lessons provide for teaching, with the aid of these prepared models and pictures, **for modelling in clay or damp sand,** and for **the drawing of all plans on the horizontal black-board, which is formed by the open lid of the modelling tray itself.**

Not only these early plans, but **all the early maps are drawn on this black-board lid,** and hanging maps are not introduced till the children have, step by step, learned to grasp the full meaning of those drawn in the horizontal position.

The Manuals contain a large number of white-on-black illustrations for reproduction by the teacher on the blackboard, and for the special benefit of young teachers, every lesson is written in full, so that the teaching may proceed step by step, and in proper logical sequence.

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STANDARD II

LESSONS FROM COMMON OBJECTS

STANDARD II

Lesson I

THINGS THAT MELT

Articles required for illustration: pieces of wax, lead, tin, glass-tubing, chalk, stone, marble, slate, brick, and camphor, some butter, tallow, and ice, an iron spoon, the Bunsen burner, and an old poker.

I. Introduction

Show the pieces of wax and lead, and commence as follows:—

I want you to think of one of your early lessons. You see I can pick up these pieces of wax and lead, and hold them in my hand. I can even throw them from one hand to the other without fear of spilling any part of them.

What name do we give to all things which we can handle in this way? We call them **solids.**

The wax and the lead then are solids. Have you ever seen them in any other form? We once saw them as **liquids.**

What must we do to change these solid things into liquids? We must **melt them.**

Do you remember how we melted them? We put them into an iron spoon, and held them over the flame of the lamp.

Then what was it that made them melt? The **heat of the flame.**

I have a number of different things on the table. We will now heat them one by one, and watch how they act.

II. Some Things melt easily

1. *Call a child to the front, and give him a small piece of ice to hold in one hand, and a piece of tallow candle in the other.*

At the same time put a similar piece of tallow, some butter, and some wax in little tin dishes, and stand them in front of the fire.

Draw attention to the ice on the table, and proceed to elicit from the class all they can tell about it.

Ice is water; but it is not liquid as we usually see water. It is **a solid.**

It **stands up** by itself; it has **a shape of its own**; it **does not spread about** and **flow** over the table; we **cannot pour it out** as we pour out water.

Turn now to the child, and ask for the piece of ice he has been holding.

Why, it is all gone. What have you done with it?

2. *Point to the floor, and show that the ice has been changing into water all this time. It was solid at first: he could hold it in his hand. As it changed into a liquid,* **it ran through his fingers** *and* **fell on the floor.**

What has happened to the ice to change it into water? It has **melted.**

What causes things to melt? **Heat.**

Where did the heat come from to melt the ice? It came **from the boy's hand.**

Then suppose we look at the piece of tallow which I put in his other hand.

Has the tallow melted as well as the ice? No; the tallow is still solid.

What do we learn from this? We learn that **ice melts more easily than tallow.**

3. *Take up the butter and tallow which have been standing in front of the fire, and show that* **both are now melted.** *They are* **liquids; they flow about in the dishes,** *and* **can be poured out.**

There is not enough heat in the boy's hand to melt these things; but they **melt readily in front of the fire.**

Show at the same time that the wax still remains solid.

The heat which melted the butter and tallow is **not enough to melt wax.**

How shall we melt the wax? Hold it in the iron spoon over the lamp.

III. Some require more Heat

1. *Have this done, and then proceed to melt some lead in the same way.*

Let the children tell, from what they observe, that although the lead melts in the spoon **it takes longer to melt than the wax did.**

While the lead is melting, show how easy it is to melt the wax by merely holding it **in the flame of a lighted match.** *It falls away readily in liquid drops.* **The lead is a long time melting** *even over the hot flame of the lamp.*

A little heat will melt wax; much more is required to melt lead.

2. *Proceed next to heat pieces of lead and tin in separate spoons side by side. Let the children watch till the lead is seen to flow about in a liquid state, and then point out that* **the tin in the other spoon shows no signs of melting.**

Why is this? The heat that melts lead is **not enough to melt tin.**

What must we do to melt the tin? We must **make it hotter.**

Very well then; I will put the spoon, with the pieces

of tin in it, into the hottest part of the fire. Watch what happens now.

Point out that it must be much hotter in the fire than in the flame of the lamp, for the spoon itself is beginning to get red-hot.

When the spoon is red-hot the tin begins to melt; but not till then.

It requires more heat to melt tin than to melt lead.

3. What is this red-hot spoon made of? It is made of **iron.**

I have something else in the fire which is **red-hot,** and that too is made of iron. Let us take it out and look at it.

Take the poker out of the fire, and contrive while doing so to **bend it out of shape.** *Call attention to it now, and elicit that the heat of the fire must have* **made the iron soft.** *We cannot bend the poker when it is cold.*

Tell that if iron is put into a very very hot fire, many times hotter than this, it will not only get soft like the poker, **but will actually melt into a liquid,** *like the lead and the tin, and* **flow about as they did** *when they were melted.*

Deduce from this that the heat of our fire, which is able to melt tin, **is not enough to melt iron,** *but will make it* **red-hot and soft.**

4. *Compare glass in this respect with iron. Hold a piece of glass-tubing in the flame of the Bunsen burner, and show that* **heat softens glass as well as iron,** *so that it will bend easily. Tell that* **glass will melt too, but requires intense heat.** *We could not melt glass in our fires.*

Picture the glass in its melted state. It then **flows about,** *and* **may be poured from vessel to vessel,** *just like any other liquid.*

It is time now to learn a new name for all these things that melt. The words **fuse** and **melt** mean exactly the same. **Things that melt** are called **fusible substances.**

IV. Things that do not Melt

1. *Place a small iron tray or dish in the hottest and reddest part of the fire, and put into it some pieces of chalk, stone, marble, slate, and brick.*

Let the children watch till the tray itself is red-hot, and then point out that none of the things in it have changed into liquids.

Tell that these things **never would become liquids**; *heat has no power to melt them. Things of this kind are called* **infusible substances.**

2. *Lastly, put a piece of camphor into a spoon, and hold it in the usual way over a flame. Call upon the children to observe what happens.*

The piece of camphor gradually **gets smaller and smaller** till it is all gone; but **it does not change into a liquid,** for there is **no liquid in the spoon.**

Camphor does not melt into a liquid as other things do; it passes away into the air when it is heated.

Summary of the Lesson

1. Heat changes some solids into liquids. We say these solids melt.

2. Some things melt very easily; others require great heat to melt them.

3. Tallow melts more easily than wax; wax more easily than lead; lead more easily than tin; tin more easily than glass or iron.

4. Chalk, stone, marble, slate, and brick do not melt with heat.

5. Things which melt are said to be fusible; those which do not melt are said to be infusible.

6. Camphor, when heated, does not become liquid, but flies off in vapour.

Lesson II

THINGS THAT DISSOLVE

Provide for illustration: half a dozen tumblers and small saucers, some loaf-sugar, salt, cochineal, sulphate of copper, soda, alum, lime, chalk, laundry-starch, blotting-paper filters, and glass funnels, an iron spoon, an evaporating dish, spirit-lamp or Bunsen burner, a few stones, a jug of water.

I. What Dissolving Means

1. *Place three tumblers of water on the table, and in sight of the children put some pieces of loaf-sugar into the first, a lump of salt into the second, and a few stones into the third. Stand a spoon in each tumbler, and ask three of the children to come to the front and stir them well.*

When this has been done, ask them to take out the sugar, the salt, and the stones with their spoons. Of course the sugar and the salt cannot be found: they cannot even be seen in the water. But there is no difficulty in taking out the stones.

Why can't we find the salt and the sugar? You all saw me put them into the water. Have you taken them out? No.

Then if you have not taken them out, they must be in the water still. I can easily prove that they are, although we cannot see them.

2. *Pour a little of the water from one of the tumblers into a saucer, and let the children taste it. They will at once tell that* **it tastes salt.** *Do the same with the water in the other tumbler. This* **tastes sweet.**

Fill another tumbler with fresh water from the jug, and hand it round for the children to taste. Elicit that this water

has no taste at all, and then point out that the water in the first two tumblers came from the same jug as this.

The water in the one tumbler now tastes salt, that in the other sweet. This proves that **the salt and the sugar have not been taken out** of those tumblers. They are still there, although **we cannot see either of them** in the water.

Let the children next dip the tip of one of their fingers into each saucer, and put it to their tongue. They can taste the salt and the sugar **even in those little drops of the water.**

3. Now what does all this show? I will tell you. It shows that there must be **some of the salt in every little drop of the water** in this tumbler; there must be **some of the sugar in every little drop of the water** in this one.

What has been done to the salt and the sugar then? The salt and the sugar must have been **broken up into very little pieces** in the water.

How do you know that the pieces must be very small indeed? Because they are so small that **we cannot see them** in the water. We only know they are in the water when we taste it. **The smallest drop of water contains some of them.**

You have learned this by tasting the water. Let me prove it to you in another way.

4. *Take two fresh tumblers; put a few grains of cochineal (partly crushed) into one, and one or two crystals of blue-stone (sulphate of copper) into the other. Fill up with water and stir carefully.*

N.B.—*Hot water will dissolve these things more quickly than cold.*

As the stirring goes on, the children will observe **the water in both tumblers change colour**—*one becoming* **crimson,** *the other* **blue.** *Pour a little out of each into a saucer, and show that* **every little drop of the water is coloured.**

What have you learned from this? These things have

been **broken up** in the water **into very little pieces,** just as the salt and sugar were.

How did you learn this? Our eyes told us; we saw the water change colour. Remember we cannot see the little pieces themselves; they are far too small. But there are so many of them that **they are able to colour every little drop of the water.**

5. You must now learn a hard word which tells us all about this. When we break up salt, sugar, and other things into little pieces in this way, by putting them into water, we say **we dissolve them.**

Solutions of soda, alum, lime, and other common things may be made and shown, at the discretion of the teacher, to vary the lesson.

II. Mixing is not Dissolving

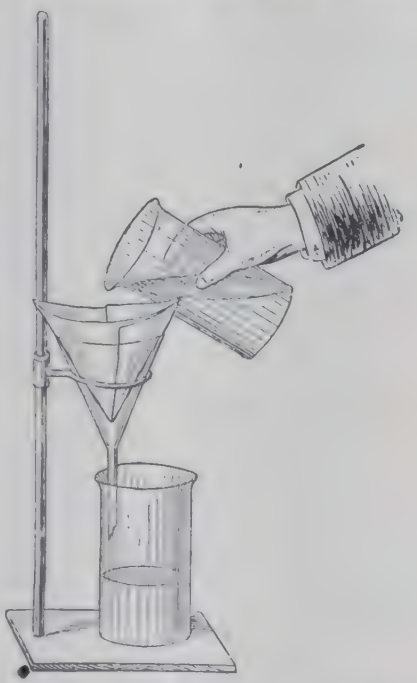
1. *Mix some powdered chalk and common laundry starch in water. Point out that both these things break up into little particles;* **but they do not disappear** *in the water. We can see them floating about in the water.* **They make the water thick and muddy-looking.**

Notice that some of the chalk and starch is **already falling to the bottom** *of each tumbler, and* **settling there in a wet layer.** *Tell that after a time it will all sink to the bottom, and* **leave the water quite clear.** *We shall then be able to pour all the water away, and* **leave the chalk and starch behind.**

Compare this with the things dissolved in the other tumblers. The salt and other things **do not sink and settle at the bottom.** *We could not take out the smallest drop of the water* **without taking a little of the dissolved substance with it.**

2. *Now carefully filter the liquids in all these tumblers through blotting-paper filters.*

The dissolved substances pass through the blotting-paper with the water. We **can still taste the salt and the sugar** in the first two; we can **still see the bright colours** in the others, because all these things are dissolved.



The chalk and starch **do not pass through the blotting-paper.** Nothing but the clear water trickles into the glasses; **the chalk and the starch are left behind, because these things are not dissolved.**

III. Melting is not Dissolving

When I first showed you that the salt and sugar had disappeared in the water, I heard some thoughtless boy say that the salt and sugar had melted. Let us see whether that is right.

Remind the children that we melted wax, ice, tallow, lead, and other things in our last lesson; and call upon them to tell how the melting was done. We held all these things over a flame. The heat changed the solid into a liquid. **We saw the liquid flow about when it was melted.** *But we did not put any of those things into water to melt them.*

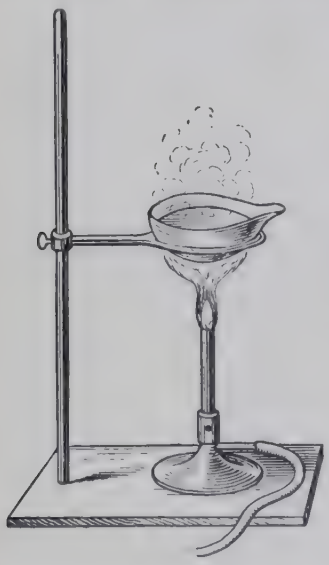
Proceed now to melt some sugar in a spoon over the flame of the lamp to show the contrast. Point out that the sugar was solid when we put it into the spoon. It now flows about. It is a liquid. We have melted it.[1]

The **sugar** and the **salt in the water are dissolved, not melted.**

[1] Salt is fusible too; but very intense heat is required to melt it. It cannot, therefore, be melted experimentally before the class.

IV. How to get the Dissolved Things back again

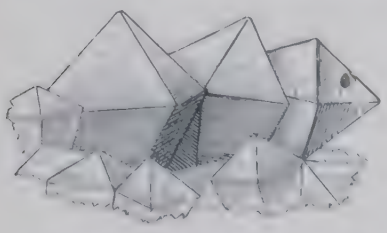
1. *Make strong solutions of salt and sugar, and put a little of each into a shallow evaporating dish over the flame of the lamp, or the Bunsen burner. It will be very interesting to the children to see the water pass away in vapour, and then learn by tasting that* **the salt and the sugar are left behind in the bottom of the dishes.**



They will then, moreover, have another proof that these things are actually in the water, although they cannot be seen. **They are dissolved in the water.**

2. *There is another very interesting method of getting the dissolved substance back again* **in the form of crystals.**

Take alum for example. Boiling water will **dissolve exactly its own weight of alum,** *and this will make a very strong solution. Prepare such a solution, and, while it is still hot, suspend in it a small wire toy of some sort, which has been previously covered with worsted. If the solution is then stood aside in a place where it may cool very slowly,* **large crystals of alum will be formed** *all over the worsted in the course of a couple of days.*



The same thing may be done with soda, sugar, or blue-stone, but alum makes the more effective show.

N.B.—*This experiment would of course have to be prepared two or three days before the lesson.*

V. Things that do not Dissolve

The last point to notice is that the stones which were put into the third tumbler, still lie at the bottom, just as they were when we put them in. They have not even broken up and mixed with the water, as the chalk and starch did.

Our last lesson showed us that stone will not melt. We now learn that **stone will not dissolve.**

All **things that dissolve are said to be soluble.** We say that **stone, chalk,** and **starch are insoluble,** because **they will not dissolve.**

Elicit from the class, and assist where they fail in naming, other things which are insoluble.

Summary of the Lesson

1. Sugar, soda, alum, salt, and lime, if put into water, break up and disappear.

2. These things break up into such little particles that they cannot be seen in the water.

3. All things which break up in water in this way are said to dissolve ; chalk and starch do not dissolve.

4. Melting is not dissolving.

5. Things which are dissolved in water can be got back again.

6. Things which dissolve are said to be soluble ; those which will not dissolve are said to be insoluble.

Lesson III

A PIECE OF SALT

The teacher will require : a lump of common table-salt, and specimen pieces of rock-salt, a hammer, a tumbler of water, the Bunsen burner and an evaporating dish, a picture of a salt-mine, a glass of sea-water (if it can be obtained) ; if not, a solution as nearly like it as possible.

I. Introduction

You remember in our last lesson we put some salt into water to find out what would become of it.

What happened to the salt? It was **dissolved.**

What does that mean? It means that the salt was **broken up** into such little pieces that **they could not be seen in the water.**

How could you tell that the salt was there if you could not see it? We proved it was there by **tasting the water.**

What becomes of the salt when it is dissolved? The little pieces **separate** and **scatter themselves** into every part of the water.

How do you know that? Because, if we take the smallest drop of the water on our finger, **it tastes salt.** There is some of the salt **in every drop of the water.**

What name do we give to salt and all other things that dissolve in water? We call them **soluble substances.**

Do you know how we can get this dissolved salt back again in solid grains? Yes; **by boiling the salt water.**

What happens then? The water flies off in steam, and **the solid grains of salt** are left behind.

II. Other Properties of Salt

1. I am glad you remember what I showed you in our last lesson. We will now try to learn something more about the salt itself.

There is a large piece of salt on the table. What can you learn by looking at it? We can see that it is a **white, solid substance.**

Notice what happens when I strike it a blow with

this hammer. What did you see? The salt broke up into pieces.

What do we say about all things that break up easily like this? We say they are **brittle.**

2. Salt then is a brittle substance. I will now give each of you a piece to examine a little more closely.

What do you learn by handling the salt? It **feels hard and rough.**

Look at it carefully, and see if you can find out why it feels rough. What do you notice? It is made up of **little grains.**

Do you know any other white, solid substance that is rough because it is made up of little grains? Yes; **loaf-sugar.**

Now take two pieces of salt and rub them together, and let us see what will happen to the grains.

Point out that some of the grains break off and fall in powder as the two pieces are rubbed together. This is the way mother powders the salt to eat with our food. None but brittle things could be powdered in this way.

3. Now dip your finger into this powder and put it to your tongue, and let us see what you can learn by tasting it.

What have you to say about the taste of salt? **It tastes salt.**

Notice the peculiarity of this. We taste sugar, and we say **it is sweet**; *we taste vinegar and call it* **sour**; *we taste various other things and find them* **bitter.** *Here we have a substance* **with a taste of its own,** *unlike the taste of anything else, and we can only say that* **it tastes salt.**

Elicit from the class that we eat salt with our food because **it makes the food taste better,** *and then point out that there is another reason why we should eat salt.* **Salt keeps us well**; *we should soon become ill if we did not eat salt.*

III. Salt—What it is

1. Now that we know something of the nature of salt, we will in the next place find out what it is, and where it comes from.

Look at your piece of salt once more. It did not grow on a plant; it never formed a part of any animal. It was got out of the ground, like clay, chalk, sand, slate, and stone. **It is a mineral.**

Deep down in the earth there are **great solid beds of salt** stretching for many miles; **not clean, white, crumbling salt,** such as this which we have here, but a different-looking substance altogether.

2. *Show a lump of* **rock-salt** *and compare it with the table-salt, which the children have just examined.*

Lead them to describe the new substance. It looks like a piece of **pinkish-brown stone,** *and is* **hard, smooth,** *and* **shiny.**

Tell that we call it rock-salt, **because it is like rock** *or stone in appearance.*

How can we prove that it is really salt and not stone? **By tasting it.**

3. Let us see what will happen if we put a piece of it into a glass of water. See, the lump is getting smaller and smaller as I stir it about; it will soon disappear altogether.

What has happened to it? It has been **dissolved**; it is in the water **although we cannot see it.**

Tell now that things dissolved in water like this are said to form **solutions.** *We have here a* **solution of salt.** *Prove the existence of the salt as usual by tasting.*

Continue to add more of the rock-salt, and as it disappears let the children test the solution from time to time. They will find that it gets **salter and salter** *in taste. We say the* **solution gets stronger.**

A **very strong solution** of salt is called **brine.**

4. *Proceed next to boil some of this brine, made from the rock-salt, in a tin dish over the lamp or the Bunsen burner as before. When all the water has been driven off in steam, show that there is something left behind,* **which we find to be actual salt by testing it.**

Notice, however, that this salt is **not like the hard, brown, shiny rock,** *which we put into the water. It lies at the bottom of the dish in little white grains.*

5. Now let us go back, and think of those great beds of rock-salt which stretch for miles underground.

What would happen if water were always soaking through those beds of rock-salt? The water would **dissolve some of the salt,** and form **brine.**

Well, this is just what does happen. You know that every time it rains some of the rain soaks into the ground. Now, whenever it soaks into a place, where there are any beds of salt underground, it always dissolves some of the salt, as it soaks through, and becomes **brine.**

6. *Lead the children now to tell all they can of the nature of a spring, and then explain that this water* **after soaking through the beds of salt** *also forms springs.*

We call them **brine-springs.**

Tell that the **white, crumbly table-salt** *we use is obtained* **from the brine** *of these brine-springs, by boiling away all the water, and leaving the salt behind, just as we did it in our little dish, except that the brine is boiled in great shallow pans as big as a room.*

But how is the brine itself got out of the earth?

Explain that men bore a hole through the ground into the bed of salt, and put a long pipe down the hole. The brine runs into this pipe and is **pumped up to the surface.**

7. In some places people **use the solid rock-salt** instead of pumping up brine and boiling it. They have to **dig the rock-salt** out of great deep holes called **mines,** which they make in the earth.

Show a good picture of a salt-mine.

It is a sort of underground town. The miners live there with their families, and rarely come up above ground. They cut out their houses, and even the stables for their horses, in the solid rock-salt. The horses never come up when once they are taken down there. They live, and work, and die in the mines.

On grand occasions the mines are lighted up to receive visitors, and the place then looks almost like fairy-land, for the shiny surface of the salt reflects the light in every direction.

IV. Salt got from Sea-Water

Show a glass of sea-water if possible. Say what it is and where it came from. Lead the children to tell, from their own experience and observation, and also by testing the water before them, that **sea-water is salt**—*almost like brine.*

What happens to brine when we boil it?

What do you expect would happen to this sea-water if we boiled it?

Boil a little of the water in a dish as before, and let the children see and taste what is left behind.

Some people get all the salt they use **from sea-water,** and not by boiling the brine of brine-springs.

Summary of the Lesson

1. Salt is a white, hard, brittle, rough substance. It readily breaks up into grains.
2. It has a taste of its own, unlike the taste of anything else. It is soluble.
3. Rock-salt is a mineral; it is dug out of the earth.
4. When salt is dissolved in water it makes a solution called brine.
5. Our table-salt comes from brine springs.
6. Salt is also got from sea-water.

Lesson IV

THINGS THAT BURN

The following articles should be provided: pieces of calico, silk, linen, woollen cloth, woollen carpet, whalebone, coal, coke, charcoal, leather, lead, solder, some splinters of wood and a few wood shavings, some feathers, hay and straw, sheep's wool and cotton wool, sponge, india-rubber, gutta-percha, an old kid glove, paraffin, benzoline, stone, clay, brick, chalk, the spirit-lamp, and two or three small tin saucers.

I. Introduction

1. *Touch a thin strip of lead or solder with the red-hot poker.*

The metal at once melts, and **falls away in liquid drops.**

Substitute for the lead some wood shavings.

These **take fire** and **burn away,** till there is nothing of them left.

Point out that the **lead does not take fire and burn**; *it simply changes from a solid into a liquid, and the liquid itself becomes solid again as soon as it gets cool. It is all there* —**none of it is consumed or burned away.**

You see from this that heat, which **makes some things melt,** causes others **to take fire and burn away.** To-day we are going to see what we can learn about the **things that burn.**

2. *Hold in the flame of the spirit-lamp with a small pair of hand tongs the following substances: a piece of calico and a piece of flannel or woollen cloth; a thin stick of wood and a strip of whalebone; pieces of coal, coke, and charcoal; a sheet of paper and a strip of thin leather. Call upon the class to observe how all these things act.*

The first point to notice about them is that they all

take fire and burn, and they keep on burning **till there is nothing of them left.**

We next observe that they do not all burn in the same way. Some of them **blaze up into a fierce flame**; some **do not flame at all,** but burn with a red-hot glow, and **smoulder away**; some **frizzle** and **splutter** as they burn; and some again **send out smoke and smell** in burning.

Elicit these points of difference from the children, and lead them to give examples of each from what they have just seen, so that lists of them may be arranged in order on the black-board.

3. Now I want you to learn two long words in connection with this burning.

All things which burn are said to be **combustible.**

All those things which burn **with a flame** are said to be **inflammable.**

Write the two words on the black-board. Call upon the children to name all the **combustible things** *they can think of, and let them say, from their own observation, which of them are* **inflammable.**

The teacher will assist of course where the children fail.

II. Some Things Burn more easily than Others

1. *Show a few feathers, and a wisp of hay or straw. There will, of course, be no difficulty in eliciting from the children that feathers are the covering of birds, that hay is dried grass, and straw the dried stalks of the corn that grows in the corn-field.*

As the feathers come from an animal we may call them **animal substance**; and as the hay and straw come from plants we speak of them as **vegetable substances.**

Now I am going to hold them in the flame of the lamp, one by one, and I want you to watch how they burn.

Point out, as the burning goes on, that the feathers only **frizzle** *and* **splutter in** *the flame. They* **burn with**

difficulty, *and not like the hay and straw, which* **blaze up instantly** *and are gone.*

2. *Repeat with the following articles, calling upon the children to note the behaviour of each as it burns :—*

Strips of leather and whalebone side by side with a splinter of wood.

A bunch of ordinary wool side by side with some loose cotton wool.

Pieces of cloth and flannel side by side with calico, print, and muslin.

A piece of silk side by side with a piece of linen.

An old kid glove side by side with a sheet of paper.

A piece of sponge side by side with india-rubber or gutta-percha.

Elicit as far as possible, and tell where necessary, which of these are **animal** *and which* **vegetable substances,** *and have them arranged in two distinct lists on the black-board, as the experiments proceed.*

3. Now let us see what we have learned from all this burning.

(1) The **animal substances** all **burn with more difficulty** than the vegetable substances.

(2) Most of them do not blaze up at all, but **only smoulder away.** Those that do flame only **frizzle** and **splutter like the feathers.**

(3) All the **vegetable substances burn rapidly with a fierce flame.**

It is important for children, and especially little girls, to know this. Their **calico** and **muslin frocks and pinafores will readily catch fire** and blaze away fiercely, if they come into contact with a flame. Children should therefore be very careful not to go near the fire.

They should also be careful to keep the lamp and the candle away from the **window curtains,** and the **bed hangings,** because these are **made of cotton,** and will **easily take fire.**

4. *Put a piece of old woollen carpet and a piece of calico, linen, or muslin on an iron tray, and drop a red-hot cinder from the fire on each. Show, from the way in which they act, how dangerous it is to hang things which are to be aired too close to the fire.*

If a spark or a cinder fly out and fall on the **woollen rug, it will only smoulder,** and the smoke from it will give warning of the danger. But if it fall on the **cotton and linen articles** hanging round the fire, **they will blaze up at once** without any warning.

III. Things that Burn in Lamps

1. *Show some paraffin and benzoline. Elicit from the children what they are, and what use we make of them. Tell that they are* **mineral oils.** *They are* **got out of the ground.**

Put a little of the benzoline into a tin saucer and apply a lighted match.

The **benzoline blazes up in an instant,** showing that it is **very highly inflammable.**

Now pour a little **cold paraffin** *into another saucer, and apply a match as before.*

The **paraffin does not take fire** and blaze up; it actually **puts out the flame of the match.**

This of course will puzzle the children, for they all know that paraffin does actually burn in lamps.

2. *Pour a very small quantity of paraffin into another saucer from a bottle which has been standing in a warm place for a few minutes.*

N.B.—*It is needless to say that a warm place does not mean "in front of the fire."*

If a lighted match be applied to this **it will blaze up at once,** *almost as fiercely as the benzoline did.*

Let me show you the meaning of this. I will pour a little of the paraffin from the first bottle into the palm of my hand, and I want you to watch what happens.

Wait till it has all disappeared, and then explain that the warmth of the hand has **changed the liquid paraffin into vapour,** *and the vapour has passed away into the air.*

3. It is **the vapour** of the benzoline and paraffin **that burns, not the liquid itself.** Benzoline is much more inflammable than paraffin, **because it is always giving off some of this vapour.** But no vapour rises from paraffin **while it is kept cold.** That is why the paraffin in the first saucer did not take fire.

The children should be warned against the danger of trimming these lamps near a flame of any sort. Tell that both liquids should be kept **in a cold cellar** *or out-house, and* **the trimming of the lamps** *should always be done* **in daylight.**

IV. Things that will not Burn

Now hold pieces of stone, clay, brick, and chalk in the flame of the lamp, or put some pieces in the fire. In the meantime take the red-hot poker out of the fire, and lead the children to tell what they have already learned about that.

The poker gets red-hot in the fire, but it does not get any smaller: **it does not burn away.** It is made of

iron, and **iron does not burn.** Like lead and tin it melts and becomes liquid if the fire is hot enough, but it does not burn away.

Take the stone and other things out of the fire now. Tell that these things **neither melt nor burn away** *in the fire.*

Explain that all things of this kind, as well as iron, are said to be **incombustible** *because they will not burn; and assist the children to add to the list of substances of this kind.*

Summary of the Lesson

1. Things which burn are said to be combustible.
2. Those which burn with a flame are said to be inflammable.
3. Some things burn more easily than others.
4. Some things, such as brick, stone, clay, chalk, and iron, do not burn. They are said to be incombustible.
5. Some liquids, such as benzoline, paraffin, and other oils, are very inflammable. We use them to burn in lamps.

Lesson V

A LUMP OF COAL

Provide the following articles for illustration: a lump of common coal, and specimens of fossil coal, a piece of wrought-iron, a hammer, a bowl of water, the Bunsen burner, pieces of stone, chalk, clay, and slate, a carrot, turnip, and potato, a long clay tobacco-pipe filled beforehand with powdered coal, and stopped with clay.

I. Its Properties

1. *Show the lump of common coal. Remind the children that this is one of the things that burn, and lead them to discover for themselves the properties of the substance in some such way as follows:—*

Let us begin by looking at it. What does it look like?

It is **black and shiny.** It looks like a lump of **smooth, polished, black stone.**

Call one of the children to the front, and let him take it up and handle it. Lead him to tell that it is a **hard, heavy substance.**

You say this lump of coal is heavy. But if I were to give you a very small piece to handle, could you learn from that whether coal is heavy or light? Yes; we could find out by putting it in water, **because heavy things sink, light things float.** *Let this be shown.*

2. This piece of iron is also a hard substance. Now take the hammer and strike the iron and the coal a smart blow, and tell me what you observe. The **coal breaks easily,** but the iron does not break.

What do we say about things that break easily? We say they are **brittle.** Coal then is a **hard, brittle substance.**

3. *Let the children examine the coal closely and they will discover that it is* **made up of flat layers.**

Instruct the boy at the table to strike one of the pieces **lengthwise,** *and show that the coal breaks up easily,* **because the layers split asunder** *with the blow. Point out that it is more trouble to break the coal* **by striking it crosswise,** *for then the layers do not separate so easily.*

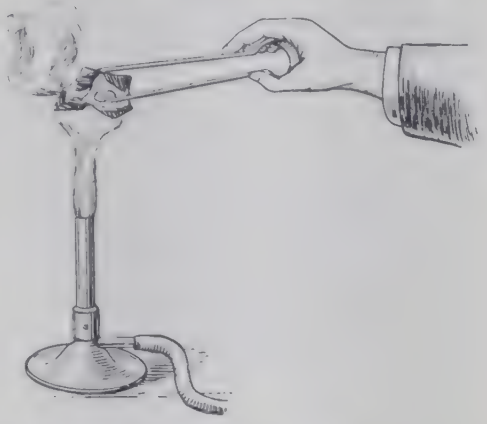
4. *Now call attention to the boy's hands.*

The blackness of the coal comes off when we touch it, and makes our hands dirty.

5. *Hold a piece of coal in the flame of the Bunsen burner with the small hand tongs, and let the class notice and tell exactly what takes place.*

First a **puff of thick smoke** oozes out from the coal, then the coal itself **swells up into a soft mass,** and then it **bursts into a bright flame.** Soon the whole lump will be in a blaze. If it were then left to burn, the

blaze would gradually die down, and the lump would get **red-hot** and **throw out great heat.** After a time the whole of the coal would be **consumed** or **burned away,** and nothing would be left but some **white ashes.**



6. We learn from this that coal is **very inflammable,** that it burns until it is all consumed, and that **it gives out great heat** while burning.

In connection with this show and compare the burning of wood, charcoal, peat, and coke.

These things all burn so well that they are **used as fuel** for making our fires, for cooking our food, and warming our houses. But coal is the best of all.

II. What Coal is

1. *Compare the lump of coal with stone, chalk, clay, and slate on the one hand, and with a carrot, a turnip, and a potato on the other.*

Which of these things is the coal most like—the stone or the carrot? It is **more like the stone** than the carrot.

What kind of things are the carrot and the turnip? They are the roots of plants; they grow in the ground.

What name do we give to the stone, chalk, and other things of that sort? We call them minerals.

Where do all minerals come from? They are dug out of the ground.

You are quite right in saying that coal is more like a mineral than a plant. It is **all in one piece;** it has **no separate parts; one piece is just like another.** Like

FOREST OF THE COAL PERIOD.

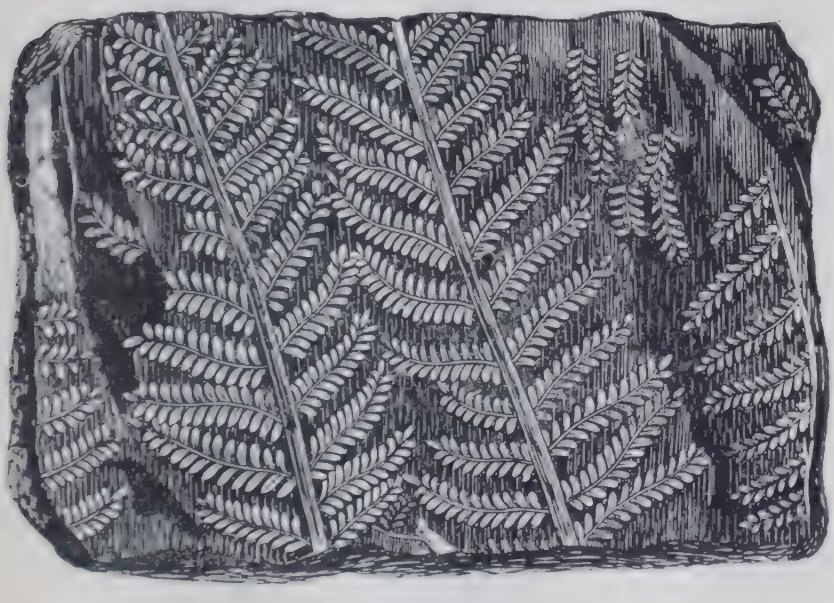
stone and all other minerals, too, **it is dug out of the ground.**

Coal is so much like these minerals that **we often call it a mineral.**

Yet, strange to say, **it is not a mineral** in the same sense as clay, stone, chalk, slate, or lead.

2. *Explain that* **coal was not always in the ground,** *as the other minerals have been.* It **was made** *in a wonderful way* **from trees and plants,** *that grew many thousands of years ago.*

Tell that some of the forests that grew on the earth in those



FOSSIL COAL.

days sank down and got buried deep in the ground, where they have been hidden away ever since.

During all this time **they have been changing** *from wood and leaves, roots and branches,* **into a new kind of mineral substance,** *which we dig up and call* **coal.**

3. I cannot make little boys like you understand how this

wonderful change took place; but we know what must have happened, because pieces of coal are often dug up with the **impression of the leaves and ferns marked upon them**, and other pieces are sometimes met with **showing the shape of the stems, branches, and bark** of those old plants.

We can thus even form a good idea of the kind of trees and other plants that grew in the forests of those distant days.

Show the picture of the forest, and an actual specimen of **fossil coal** *if possible.*

III. Coal-Gas

1. *Take a long clay tobacco-pipe; fill the bowl with powdered coal, and cover up the top perfectly close with clay.*

N.B.—*To ensure success with the experiment it is best to do this preparation-work beforehand, as the moist clay is almost sure to crack with the heat, and that would interfere with the working. If it were done the day previous to the lesson, the clay would be quite dry before it was wanted. The teacher would of course show and explain with another pipe what had been done.*

We are going to put the bowl of the pipe into the fire, and I want you to watch the other end of it, and see if you can find out what happens.

In a little while some **light-coloured smoke** *is seen coming out from the stem of the pipe.*

2. *Hold the back of a plate against the cloud of smoke, and show that some of it settles on the plate, forming* **a sticky black coating there, with the smell of tar.**

Apply a lighted match to the smoke as it issues from the pipe. **The smoke takes fire and burns** *with a dirty, smoky flame.*

3. *Blow out the flame, and ask the children to watch till they see the bowl of the pipe get red-hot.*

Can you see any smoke coming out now? No

I will prove to you that, although you can see nothing, yet there is really something coming out of the pipe.

Apply the lighted match as before. *A* **bright yellow flame,** *quite distinct from the smoky one,* **now bursts forth.** There is something really **inflammable coming out of the pipe,** and that something has been made from the coal which is burning in the bowl.

If we blow out the flame we shall not see anything, but the lighted match will soon prove to us again that the same substance is still pouring out from the pipe.

4. *Take the pipe out of the fire now and let it cool.*

While it is cooling turn on the tap of the gas-burner for a moment, and show that although nothing is to be seen coming from it, a lighted match at once tells us that some inflammable substance is being given off, for **it instantly bursts into a bright flame.**

What do we call the substance that is burning in the gas-jet? We call it **gas.**

Tell that this is the very substance we have been making in the bowl of the pipe. **Its proper name is coal-gas.** *The* **black sticky stuff** *on the plate, which smells like tar,* **is really tar—coal-tar.** *It always comes off from the coal when gas is being made.*

Lastly, break the bowl of the pipe and show its contents.

What is this? It is all that is left of the coal when the gas and tar are taken away. We call it **coke.**

Summary of the Lesson

1. Coal is a black, shiny, hard, brittle substance.

2. It burns easily and throws out great heat; we use it for fuel.

3. Coal is dug out of the earth; it was formed from trees and other plants which once grew in the ground. It is not a mineral.

4. The gas which we burn in our houses is made from coal. Its proper name is coal-gas.

5. Tar and coke also come from coal.

Lesson VI

CARBONIC ACID GAS

The teacher will require a small flask, fitted with a bent tube and a thistle funnel ; some pieces of marble, chalk, or limestone ; hydrochloric acid and water ; some gas-jars ; a piece of candle and a taper ; some lime-water ; a small saucer.

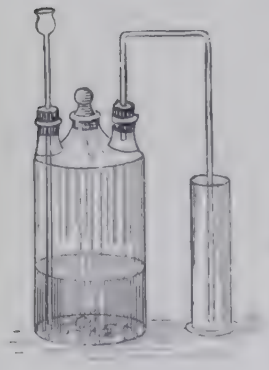
I. Properties

1. *Prepare some carbonic acid gas as follows :—*

Put a few broken pieces of marble, chalk, or limestone into a small flask, fitted with a bent tube and a funnel. Pour enough water down the funnel to cover them, and then add a little hydrochloric acid.

Call attention to the bubbling that at once commences in the liquid. The bubbles pass up through the liquid and burst on the surface.

While the bubbling is going on, dip the other end of the bent tube into a gas-jar.



The gas is easily collected by downward displacement, and it would be advisable to fill three or four of the jars before proceeding.

That done, the properties of the new gas may be shown as follows :—

2. *Plunge a burning taper into one of the jars.* **The flame is instantly extinguished.** *Show the difference when the taper is relighted and plunged into another jar containing ordinary air.*

Elicit that, whatever is in this first jar, it cannot be air, because **air would not put out the flame;** it would help the flame to burn.

Let the children examine the jars now. They **see nothing; they smell nothing.**

Remind them that in our last lesson when we turned the gas-burner on, we saw nothing, but we soon began **to smell the gas** *as it came out.*

Tell that this new substance in the jars must be **an invisible gas,** *like the coal-gas that poured out from the gas-pipe, but unlike that* **it has no smell.**

What happens when we put a light to the gas-burner and turn on the tap? The gas **takes fire and burns.**

What happened just now when I put the lighted taper into the gas in that bottle? **The flame went out,** but **the gas itself did not take fire.**

This new gas **is not air,** and it **is not coal-gas.**

3. Now think for a moment. When we collected the gas, we simply let it pour down the tube into the jars like water.

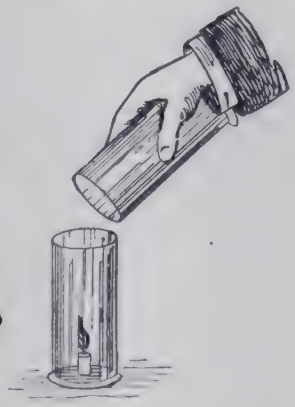
What was there in the jars at first? Air.

What has become of the air then? Let me show you.

Pour some water slowly into another "empty" jar.

The water settles at the bottom of the jar. Why? Because **water is heavier than air.**

What becomes of the air in the jar, as I continue to fill it up with water? The water **pushes it up,** and **drives it out of the jar,** so that it may take its place.



Now tell me why this new gas poured down the tube, and filled the jars, when they were already full of air? **This gas** must be **heavier than air.** Like water **it sinks to the bottom of the jar,** and pushes the air out above it.

Fix a piece of burning candle at the bottom of a bottle containing only air, and pour the gas from another of the jars into it, as though it were water. Observe that although we cannot see the gas pour out from one vessel

into the other, we know that it does so, **for we see that it at once puts out the flame of the candle.**

4. *Take a third bottle of the gas now, and pour into it some clear lime-water.*

Explain what has been done, and then shake the jar well for a minute or so, calling upon the children to observe the change that takes place.

The clear lime-water becomes white and milky-looking.

Tell that there is only one substance that can make this change in clear lime-water, and that is a gas called **carbonic acid gas.**

We know the gas in these jars is **carbonic acid gas,** because it gives clear lime-water **this milky appearance.**

II. Burning and Breathing

1. *Take a clean glass bottle with a narrow neck, and lower a burning taper into it.*

Let the children observe that after it has burned for a few minutes, **the taper gradually dies out.**

Remove the taper now, pour some clear lime-water into the bottle, and shake it up.

What do we see? **The lime-water has become white and milky-looking.**

What does this prove? It proves that there is **carbonic acid** in the bottle.

Point out that when the burning taper was first lowered into the bottle, there was nothing in it but air. The **carbonic acid gas has been formed by the burning of the taper.**

2. *Tell that* **all our fires** *and* **furnaces,** *all our* **lamps for lighting,** *all* **burning of every sort, produce carbonic acid gas.**

Pour some clear lime-water into a tumbler, and set one of the children to breathe or blow air into it through a straw or a piece of glass tubing.

Call attention to the change which takes place in the lime-water.

There is the same **cloudy milkiness** *as we have seen before.*

What does this prove? It proves that **the air which we breathe out contains carbonic acid gas.**

III. Carbonic Acid Gas in the Air

1. Our breath and the breath of all animals contains carbonic acid gas, and every fire that burns produces carbonic acid gas.

What becomes of it? It mixes with the air.

Look at this saucer. I filled it with clear lime-water early this morning.

What do you notice about it now? It has **the same milky, cloudy look** on its surface as we saw in the tumbler when we breathed into the lime-water.

What does that prove? It proves that **carbonic acid gas has been acting on the lime-water.**

Where did the carbonic acid gas come from? It must have come from the air. **There is always some carbonic acid gas in the air.**

2. *Point out that there is only* **a thin film on the surface** *—the water below is clear enough.*

That tells us plainly that after all there is **only a very small quantity of carbonic acid gas in the air**; and yet with fires and animals always making it, we might have expected to find a very large quantity always present in the air. How is this?

3. *Explain that* **every plant** *that grows* **takes in carbonic acid gas from the air,** *and uses it to build up its own substance.* **It is the food of plants.**

This is why there is never very much carbonic acid gas in the air. As quickly as it is formed by breathing and burning, **it is taken in by plants as their food.**

Point out the all-wise arrangement of this.

Men and animals breathe out carbonic acid gas, **but they could not breathe it in.** It is a **highly poisonous gas.** It would **kill us,** and all the animals around us, if we breathed it, as surely and as quickly **as it killed the flame of the candle.**

The **plants take out of the air,** as their food, **the very thing that would be deadly poison to men and animals.**

Summary of the Lesson

1. Carbonic acid is an invisible gas, and it has no smell.
2. It is so heavy that it can be poured out like water.
3. It puts out a flame; it does not take fire itself.
4. It turns clear lime-water white and milky-looking.
5. Carbonic acid gas is produced when things burn.
6. We give off carbonic acid gas when we breathe, and so do all animals.
7. Plants feed on the carbonic acid gas in the air, which is a deadly poison to us and to all animals.

LESSONS FROM PLANTS

Lesson VII

SEEDS

Provide for illustration: some mustard and cress seedlings growing on flannel, in a saucer of water. Nothing more need be done than to lay the flannel in the saucer with water enough to keep it moist, and the seeds after being soaked can be spread over it with a knife. Of course this should be done about a week or ten days before the lesson. The saucer must be kept in a warm room, and a little water should be added from day

to day to prevent the flannel from getting dry. Provide also some soaked beans for examination, and a few common seeds, such as peas, acorns, almonds, plum and cherry stones, etc.

I. Introduction

Commence by referring the children to their early lessons on plants, and direct their thoughts especially to the flower and its work. Lead them to tell in a simple way that the flowers have to produce seeds, which will grow up into new plants, to take the place of the old ones when they die.

Tell that we are now going to examine the seeds themselves, and try to find out how they grow and become big plants.

II. Food-Store in the Seeds

1. *Produce the mustard and cress seedlings growing on the flannel.*

Show at the same time specimens of the actual seeds from which these little plants grew.

Think how big each plant is already, compared with the seed from which it sprang. They have all been **growing** ever since I first put them in.

What is it that makes little boys and girls grow big and strong? **The food which they eat.**

What do plants require, as well as ourselves, to make them grow? **They require food.**

2. Here is a big plant growing in a flower-pot. Can you tell me where it finds the food which it wants? **Its food is in the soil** in the flower-pot; **the roots of the plant suck up what they want.**

Just so. Now let us look at these little seeds. They began to grow as soon as they were put on the moist flannel, but you see **they have no roots** for sucking up food, and **there is no food here** for them to suck up.

They **cannot feed on flannel,** and there is nothing else in the saucer, except a little water to keep the flannel moist.

The water itself **contains no food** for the little things. Where then can the food have come from to make them grow?

Have you ever seen anything like this before?

3. *Remind the children of the* **growing carrot-tops, onions,** *and* **potatoes,** *which they saw in their early lessons, and lead them to tell how these things live and grow.*

They feed on their own substance, while they are sending out new roots below, and new stems and leaves above.

The carrot, onion, and potato **contain a store of food to feed the growing plant,** till it is able to send out fresh roots, and get its own food from the soil.

What did you notice about all of them, when they had been growing for some time? They were **soft, flabby, and shrivelled up.**

Why? Because they had been **giving up their own substance** to feed the growing plant.

4. *Tell now that all seeds act in just the same way.* **They contain in themselves a store of food,** *to feed the little plants which come from them, till they get roots of their own, and can feed themselves from the food in the soil.*

The little plants which spring from the seeds are known as **seedlings.**

Look at our seedlings on the flannel. What will become of them when all the food laid up in the seed itself is gone? **They will wither and die,** for they **cannot get any food out of the saucer.**

III. Parts of the Seed

Produce the bean seeds that have been in soak. Let the children examine them and tell what they are. Explain that the reason for choosing large seeds like these and soaking them beforehand is, that we may be able to find their different parts

easily. Hand them round the class, and assist the children in their investigation as follows:—

1. **The Testa.**—*Notice first the* **loose wrinkled skin** *that covers the seed.*

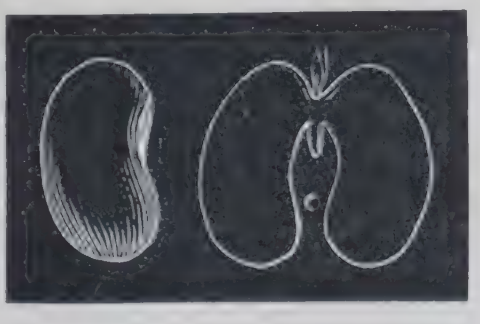
Compare with a seed that has not been soaked.

We call this tough outer skin of the seed the **testa.**

Call upon the children to point out its use as a **protecting covering** *for the inner kernel.*

Notice the **long black scar** *along one edge of the seed. Tell that this scar marks the spot* **where the seed was joined to the pod** *in which it grew.*

2. **The Seed-Leaves.**—*Slit the testa carefully with a knife,*



and remove it so as to expose the inner parts of the seed.

Show that the seed really **consists of two pieces** *placed side by side.*

Each piece is **thick and solid.** We call them the **seed-leaves.**

Point out that these seed-leaves are not separate, but are **joined together by a sort of hinge** *on the side where we noticed the scar.*

Spread the two parts open carefully to show the little hinge which joins them.

3. **The Germ.**—*Tell that* **this little hinge,** *as we called it, is* **the most essential part of the seed,** *for it is the part which is to grow into a new plant.*

We call it **the germ of the new plant.**

Show its two parts—one called the **plumule,** *pointing upwards; the other, the* **radicle,** *pointing downwards.*

Have these two parts examined carefully. Point out that the plumule is really **a tiny bud,** *which will make its way upwards through the soil, and* **form the stem and leaves;** *while the radicle will force its way into the soil, and* **form the root of the plant.**

Radicle means **a little root.**

Each seed then contains in itself the **germ,** or **beginning** of a little plant—a tiny thing containing all the essential parts of a new plant—**root, stem, leaves**—and only waiting the opportunity to grow.

4. But what then is the use of the thick, solid, fleshy seed-leaves? Let me tell you. These seed-leaves are thick and solid, **because they contain a store of food, sufficient to feed the tiny plant,** till it has grown big enough and strong enough to find its own proper food in the soil.

5. *Now that the parts of the bean seed have been clearly grasped, it would be well to hand round the class for similar examination smaller seeds of the same kind, commencing with a few peas, acorns, and almonds, the kernels from plum and cherry stones, and so passing on to apple-pips, and even some of the very small seeds of our common garden plants.*

*It cannot fail to interest the child to see that he is able to find exactly the same parts—***germ** *and* **seed-leaves**—*in the little seeds as in the large ones.*

Our little seedling mustard and cress plants on the flannel have been living and growing all this time **on the food, which was stored up in the two seed-leaves** of the seed.

Summary of the Lesson

1. Plants grow from seeds.
2. The seed contains a store of food to feed the little plant till it can get its proper food from the soil.

3. Most seeds have two seed-leaves with the germ between them like a little hinge.

4. The germ of the seed consists of the plumule and the radicle.

5. The plumule grows upwards and forms the stem and the leaves.

6. The radicle (little root) makes its way down into the soil.

Lesson VIII

HOW SEEDS GROW

Grow in preparation for the lesson some wheat and oats on a sponge, as the mustard and cress seed was grown on the flannel. This is easily done by fixing a large sponge in a cup, with just enough water in the cup to keep the sponge damp. If the seeds are sprinkled over the sponge they will soon begin to germinate in a warm room. Grow also, in boxes of mould, some peas, beans, and corn for inspection. As these will be wanted in various stages of growth, it will be necessary to set the seeds at regular intervals, ranging from a month to a few days before the lesson. Some soaked grains of wheat and maize, and a thin, sharp knife will also be required.

I. Introduction

Commence by showing the seedlings of wheat and oats growing on the moist sponge, and lead the children to tell, by referring them to the teaching of the preceding lesson, that these little plants, like the mustard and cress on the flannel, must have been living and growing on the food stored up in the seeds.

Let us examine some of these seeds now, and see what we can learn about them.

Hand a few grains of wheat round the class. Call upon the children to note the little **rounded scar** *at the broad end*

of the grain. Tell that this scar marks the spot **where the grain was attached to the ear** *in which it grew. Show an ear of corn, and point out where each grain is* **joined to the central stalk.**

Tell that, like all other seeds, **the corn-grain has its germ,** *which is to grow up into a new plant; but in this case the germ is so small that* **it all lies just under the little scar.**

As the germ of the wheat is so very small, I have got some grains of Indian corn. They are exactly like the wheat in structure, but they are larger, and we shall be able to find the parts better.

II. A Grain of Corn

Hand round some maize, and point out that these grains are very hard and brittle. We could not cut them as they are. Those which are to be examined have been in soak for three or four days.

1. **Two distinct Parts.**—*Proceed now, in sight of the children, to cut through one of the soaked grains lengthwise from top to bottom with a thin, sharp knife, so as to divide it into two broad flat halves. Let the children examine these two sections.*

What do we see? The knife has cut through something in the centre **quite different from the rest of the grain.**

Let us take away the two halves of this central part. All the rest of the grain in which that was placed is of one character. It is simply a mass of matter which has become somewhat soft through the soaking, but in the dry grain is hard and brittle.

Explain that the corn-grain is not merely a seed—that the

actual seed is the part which we found embedded in the centre of the grain, and which has just been removed.

2. **The Seed.**—*Take another of the soaked grains, and carefully remove with the knife all the outer mass of soft substance,* **so as to leave the entire seed free.**

Let the children examine it, and point out that like the seeds of their last lesson **it has a germ,** *with two essential parts—the* **plumule** *and the* **radicle.**

3. *Next call attention to the outer part of the seed.*

This outer part is all in one piece, and **folds itself quite round the germ,** as if to protect it.

How were the plumule and the radicle of our other seeds protected? They were **enfolded by two seed-leaves.** Now I want you to remember that in the corn-grain we have the same arrangement, with one difference.

Spread the seed-leaf out as far as it will go, and show that it is all in one piece.

What do you think this part is, that folds itself round the germ? It is the **seed-leaf.**

Then what is the difference between the bean seed and the seed in the corn-grain? The bean seed has **two seed-leaves**; the corn-grain **has only one.**

4. **The Food-Store.**—*Notice that this seed-leaf is* **not thick, solid, and fleshy,** *like the seed-leaves of the bean, and lead the children to deduce the reason for this.* The seed-leaf of the corn-grain **is not meant as a store-house of food** for the little plant.

Explain that **this food-store is laid up,** *not in the seed-leaf, nor in any part of the plantlet itself, but* **in the mass of matter outside it,** *with which the grain is filled.*

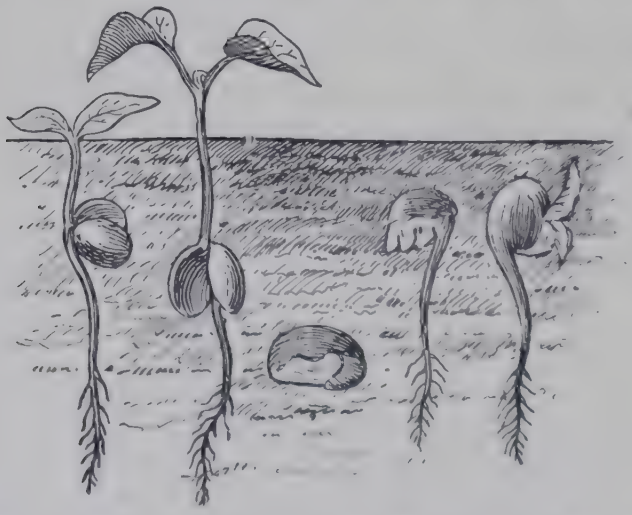
III. Germination

1. *Show now some peas and beans, and some little corn-plants in boxes or pots of mould, in various stages of growth. To secure this they should have been set at intervals varying from a month to a few days before the lesson, and kept all the time under favourable conditions of warmth and moisture.*

Commence with the beans and peas; and taking up one or two of the most recently set seeds, let the children tell what they observe.

What do you notice about these seeds? The **outer skin** of all of them is **swelled** and **wrinkled up**; in some of them it has **burst open.**

Explain that this is the first effect of the moisture on the seeds, and then tell that while this has been going on, the



warmth and moisture *together* **have made the tiny germ wake up** *as it were from its long sleep, and stretch itself out.*

Point out that until now the germ has actually been in a sort of sleep—alive, but **showing no signs of life.**

The testa splits just when the germ is trying to force its way out; **for as soon as it wakes up from its sleep, it begins to grow,** and wants more room.

2. *Lift other specimens of the growing plantlets carefully one by one, and let the children see for themselves the gradual development of the parts* **upwards** *and* **downwards.**

Let them trace the radicle in successive plants—at first **only a simple tap-root,** *very small, and forcing its way downwards into the soil; then gradually sending off (as it increases in size)* **tiny branches** *or* **rootlets** *all round.*

3. *Follow the upward growth of the plant in the same way. Show one specimen* **with the seed-leaves just opening,** *and the plumule forcing its way upwards between them.*

Then pass on to another **with the seed-leaves just making their way above-ground,** *and the growing bud of the plumule already in the act of bursting into leaf. Then show one with* **the seed-leaves withered and falling off.** *Their feeding work is done.*

N.B.—*Note that the seed-leaves of the pea do not make their way above the surface. They remain buried in the soil; but they too wither and fall off when their work is done.*

THE GERMINATING GRAIN OF CORN.

4. *Show that there is the same gradual growth in the case of the corn-grains. Point out that these plants* **never send down a tap-root first. A whole cluster of root-fibres spring at once** *from the radicle, and make their way downwards into the soil.*

Tell the reason. The food-store in these seeds is very small, and **the little plants have to get their own food from the soil very early in life.**

Show that in this case the whole of the grain withers in the ground as soon as the little plant is able to take care of itself.

Summary of the Lesson

1. The corn-grains have only one seed-leaf.
2. The food-store is laid up, not in the seed-leaf, but in the grain itself.
3. The grain withers in the ground, and the seed-leaves of other seeds fall off, when their feeding work is done.
4. But by this time the young plants have roots of their own, and can get their food from the soil.

Lesson IX

THE ROOT AND ITS WORK

Provide for illustration : pictures of the various forms of roots, a healthy growing plant in a flower-pot, and a similar one that has been allowed to die through neglect ; one or two beakers, some common garden-mould, blotting-paper filters and a glass funnel, the Bunsen burner, evaporating dish and tripod, some dry roots of plants, and a tumbler of water.

I. Introduction

Commence with a brief recapitulation of the teaching of the earlier lesson (Stage I. Lesson VIII.), leading the children themselves to tell all they know of the nature of the root, and its important work of feeding the plant with food from the soil.

As actual specimens were used for illustration and experiment in the lesson itself, pictures of the various forms of roots will now suffice for recapitulatory purposes.

See that the children understand clearly the difference in function between the fibrous and the fleshy roots.

Notice the curious forms of some of these fleshy roots, and point out that whatever the form may be, the work is always the same. These roots act as **a store-house of food,** *to feed the plant when it cannot get its proper food from the soil.*

Lastly, show the **root-hairs,** *and remind the children that these after all are the feeders of the plant. The plant has to take in all its food* **through these delicate hairs.**

II. Plant-Food in the Soil

1. *Show a healthy, vigorous plant of some sort, and side by side with it a dead one, similar to that which was used in Stage I. (Lesson VIII.) Call attention to the dry condition of the soil in which this one stands.*

This plant, as you know, died **because it was not watered.** The other has been watered carefully from time to time, and you see it is alive and healthy.

There is plenty of food for both of them in the soil in those pots, **the very food they want too,** and yet one of them has **actually been starved in the midst of plenty.** It has died for want of food. Let me show you how this is.

2. *Put a little common garden-mould into a tumbler or a beaker, fill up with water, stir well for a minute or two, and then stand it aside to settle. (Distilled water of course would be best for this, if it can be obtained.)*

As the water clears, call attention to **the sediment** *at the bottom of the glass.*

Why does all this solid stuff settle at the bottom? Because **it is insoluble.** It will not dissolve in the water.

Do you remember seeing anything else like this? Yes; **chalk** and **starch** are **insoluble,** and **they settle at the bottom of the water.**

We are certain then that this part of the mould has not been dissolved. Let us see next whether the water has dissolved any of it.

3. *Pour off the clear water into another beaker, and filter it through a blotting-paper filter. While it is filtering recall the similar experiment in Stage II. Lesson II., and lead the*

children to tell that **things which are dissolved pass through the blotting-paper with the water.** *Show the thin layer of undissolved matter left behind on the blotting-paper.*

Now look at this clear water. Does it contain any dissolved matter? We cannot tell.

Why not? Because when things are dissolved they are broken up so small that **we cannot see them in the water.**

4. What is a good way to get all dissolved things back out of the water? **We can get them back by boiling,** just as we got the salt and sugar back.

Let us try this now then.

Pour the solution into an evaporating dish, and evaporate in the usual way over the flame of the spirit-lamp or Bunsen[1] *burner. Call attention to the residue left behind in the dish.*

This is solid matter which the water dissolved out of the garden-mould. This **dissolved matter from the soil is the very food which plants require.**

III. How the Root feeds

1. Now let us turn our attention once more to the root itself. We have already spoken of the **delicate white threads,** which stretch out into the soil in all directions from the sides and ends of the roots themselves.

What do we call these? The **root-hairs.**

These root-hairs, you remember, are the **feeders of the plant.** Every particle of food, which the plant gets from the soil, **has to pass through those thin delicate hairs.**

If our eyes were sharp enough to see them, we should find that each of these root-hairs is made up of a closely-packed mass of **little cases or cells, with extremely thin spongy walls.**

[1] The Bunsen burner where it can be used is, of course, best for all experiments of this sort, because it is quicker.

Make a sketch of the tip of one of these root-fibres as it appears under the microscope.

2. Now think for a moment. What happened to the water which I poured on the blotting-paper just now? The water, **and all that was dissolved in it,** passed through the blotting-paper. **The undissolved matter could not pass through.**

Tell that the thin, delicate cell-walls of the root-hairs act in much the same way as the blotting-paper.[1] **They allow the water,** *and* **whatever is dissolved in it, to pass through them** *from the soil into the root itself; but* **nothing can pass which is not dissolved.**

3. *Take one of the dry roots which lie on the table, and put it into a glass of water. After leaving it there for some time, remove it from the glass, and show that some of the water has disappeared.*

This water **has been taken up,** or **absorbed,** by the root-hairs.

Sum up the results of the teaching in some such way as follows:—

We have learned—

(*a*) That the soil **contains just what the plant requires.**

(*b*) That the plant **cannot take it up in its solid form.**

(*c*) That water (either rain or otherwise) is **necessary to dissolve it.**

(*d*) That the dissolved matter of the soil is **absorbed by the root-hairs** to feed the plant.

4. *It would be interesting before closing the lesson (if time allowed) to picture the delicate root-fibres forcing their way little by little through the hard, rough, and sometimes stony*

[1] It is advisable not to attempt any further explanation at present. The passage of liquids through the actual cell-walls by the process of osmosis is far too intricate for these young children.

soil. Show a magnified drawing of the end of one of them, and call attention to the **cap** *or* **sheath which covers it.**

Tell that this cap or sheath is **to protect the end of the delicate thread** *as it pushes its way; that, like everything else,* **it gets worn out with its work;** *that as it wears away* **another cap forms to take its place.**

5. *Another interesting fact is that the root-hairs not only take in liquid food from the soil, but also* **give up to the soil** *in return more or less liquid, which has been prepared in the plant itself. This liquid which oozes out from the root-hairs is* **slightly sour** *or* **acid.**

Many of the food materials in the soil **require an acid in some form, to make them dissolve quickly.**

Lead the children to see the wonderful provision of Nature in all this.

Summary of the Lesson

1. The plant takes in all its earth-food through the root-hairs.

2. The solid earth-food in the soil must be dissolved before the roots can take it up.

3. Water is necessary to dissolve it.

4. Some of the food materials in the soil require an acid to make them dissolve quickly.

5. The root itself gives up to the soil a sour, acid liquid, which is prepared in the plant for this very purpose.

Lesson X

LEAVES AND THEIR WORK

The teacher will require some common leaves of various sorts for examination, and a sketch of the under-surface of a leaf as seen through the microscope.

I. Introduction

1. *Hand a few common leaves round the class, and by referring the children to the earlier lesson (Stage I. Lesson XII.), proceed to elicit point by point, as follows:—*

How many parts has your leaf? **Two parts.**

What do you call them? The **blade** and the **footstalk.**

Show me these two parts.

What is the use of the footstalk? **It joins the leaf to the twig** on which it grows.

2. Now look at the blade. Do you notice any difference between the two sides? Yes; one side is **smoother** and **darker in colour** than the other.

Look at this growing plant in the flower-pot, and show me which is the smooth, dark side of the leaf.

The **smooth, dark side** of the leaf is always **the upper side.** It is spread out to the sun and the air.

Now look at the under side of the leaf. Do you see anything there which you cannot find on the other side? Yes; there are **several thick, stout ridges** on this side; but there are none on the other.

What do we call these ridges? The **ribs.**

What are they meant for? They are meant **to support the blade,** and **keep it spread out.**

Where do these ribs all begin? They begin **where the footstalk ends.**

Where do they end? **Near the outer edge** of the blade.

3. *It would be interesting to notice the different arrangement of these ribs in different leaves. Some leaves have* **one single stout rib** *running through the middle of the blade. This is known as the* **mid-rib,** *and other smaller ones branch out from it to the edges of the blade. Some again have* **several ribs of almost the same size,** *stretching across the blade.*

The collection should contain specimens of all for inspection.

II. The Veins

1. *Instruct the children next to hold their leaves up to the light, and see if they can discover anything more about them which has not yet been noticed.*

What do you see? A great many other lines **smaller and finer than the ribs.** They **run all over the blade,** and branch out in all directions.

Lead the children to trace these branching lines across the blade, and show that **they all spring from the ribs.** *They are really very fine branches of the thick ribs. As they spread through the leaf they send off* **smaller and smaller branches.**

Have the leaves held up to the light once more, and show that these fine branching lines **form quite a network** *all over the blade.*

We call these fine lines the **veins,** and **the ribs** besides being a support to the leaf **are veins** as well, although they are so much **thicker and stouter.**

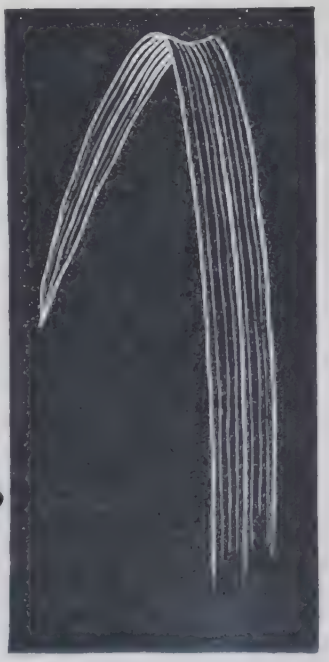
2. *Call attention to the veins in the hand. Elicit from the children (or tell if necessary) that* **these veins are full of blood**; *that this blood flows along through them into all parts of the body* **to keep us alive**; *that we could not live unless fresh blood continually flowed through the body, and so on.*

Tell that the **dissolved earth-food** *which the roots take up becomes the* **blood of the plant.** *We call it the* **sap. It keeps the plant alive.** *It passes upwards from the root, through the stem, branches, and twigs, along the footstalk, and so* **into the veins of the leaves.**

3. It is time now to learn a name for all leaves like those we have been examining. We call them all **net-veined leaves.**

Perhaps you can tell me why? **Because the veins spread out like a network** all over the leaf.

Tell that these are the commonest of all leaves. The trees of our woods and forests, and the fruit trees in our orchards, have net-veined leaves, and so have most of the plants in the garden.



4. *Show now a maize (Indian corn) leaf, or the leaf of the common flag, and continue as follows:—*

Now let us look at this leaf. In the first place show me its footstalk.

The children, of course, will be unable to find any footstalk to this leaf.

Point out by means of a living specimen of some sort, or a picture, that the **blade rises direct from the stem** *without any footstalk, and that it is* **a long, narrow, pointed leaf.** *It is something* **like a long ribbon**; *we sometimes call leaves of this kind* **ribbon-leaves.**

5. *Direct the children next to look for the veins, holding the leaf up to the light as before.*

Can you see a network running through this as you did through the other leaves? No; **there is no network of veins.**

Are there any veins at all in this leaf? Yes, there are veins; but **they run side by side in straight lines from one end of the leaf to the other.**

Explain that these are sometimes called **straight-veined leaves.**

Tell that we have very few plants with these straight-veined leaves in our country. The commonest are the **corn-plants** (*wheat, barley, oats, rye, maize*), *the* **tulip, onion, lily, common flag,** *and* **hyacinth** *among flowering plants of the garden, and the* **reeds** *and* **rushes** *that grow by the banks of rivers.*

6. I want you now to remember two things about the leaves of plants.

(*a*) Those plants which come from a seed **with two seed-leaves** (like the Bean) have **net-veined leaves.**

(*b*) Those which come from a seed **with a single seed-leaf** (like maize and wheat) have **straight-veined leaves.**

III. The Breathing Work of the Leaves

1. I must now tell you (because you could not find out for yourselves) the most wonderful thing of all about leaves. Suppose you look at this drawing and I will explain to you what it is.

Show a drawing of a piece of the under-surface of a leaf as seen through the microscope.

Call attention to the **stomata,** *without of course mentioning the name.*

Explain that the surfaces of leaves are **crowded with holes** *like these; and that there are* **more of them on the under** *than on the upper surface.*

Look at this lime-leaf. Our eyes are not sharp enough to see the holes or pores on it, but **they are crowded thickly together**, hundreds upon hundreds in every part of the leaf. Think how very small, and how close together they must be.

2. **These holes** are called the **breathing pores** of the leaf, for the plant **breathes** or **takes in air** through every one of them. But what can a plant want with air?

This of course will be quite new to the children. They know that animals require to breathe, but they have never looked upon plants as breathing things.

Remind them of what was taught in the lesson on carbonic acid gas, and lead them to tell that every plant that grows takes in carbonic acid from the air, and uses it as its food to build up its own substance.

The plant actually breathes in this carbonic acid gas through these breathing pores in its leaves. It takes from this gas (which is poison to animals) the very thing that it wants for its own support, and gives out the rest to the air again.

Explain that the dissolved earth-food or sap, which the roots obtain from the soil, is useless to feed the plant until it has passed through the leaves. In the veins of the leaves **this sap is spread out to the air** *on all sides.* **During the bright sunshine it gives up** *to the air a great deal of the* **watery part which it does not want,** *and it* **takes in from the air the very thing that is necessary** *to change it into real food to satisfy the wants of the plant.*

Summary of the Lesson

1. A leaf consists of the blade and the footstalk.
2. The ribs support the blade, and keep it spread out.
3. Veins spread through the leaf-blade.
4. The earth-food, taken in from the soil by the roots, flows through the veins of the leaves.
5. In some plants the veins spread out like a network all over the leaf. These leaves are called net-veined leaves.
6. In some plants the veins run side by side in straight lines. These leaves are called straight-veined leaves.
7. The leaves breathe through their breathing-pores.
8. They take in carbonic acid gas from the air. This is the plant's air-food.

Lesson XI

THE WOODY STEMS OF PLANTS

The teacher will require for illustration a piece of oak-stem with bark complete, and a piece of a one-year-old oak sapling (if it can be obtained); a slip from the branch of some growing tree, a few oak-leaves, and as many specimen leaves from other trees as can be procured; some acorns, a piece of sugar-cane or bamboo, a picture of the growing sugar-cane, and a pocket-knife.

I. Introduction

Introduce the lesson with a little chat about the gardening operations of the early spring, with a view to elicit from the class that spring is the season for sowing their garden seeds. Most children have their own little corner in the garden, and even in the crowded parts of our large towns, where a garden is out of the question, children will often take a pride in rearing a few plants in window boxes, and this, it is needless to say, is a thing that should be fostered and encouraged.

Lead them to tell that the plants which come from those

spring-sown seeds **live only through the one season**; *that they have* **soft, green stems**; *and that they* **wither and perish as winter approaches.** *The name* **annuals,** *as applied to these plants, may now be given, if it was not given in the earlier lessons.*

Lead them next to tell that there is another class of plants, which **live longer than one season,** *but be careful to point out that it is* **only the part in the ground that lives through the winter**—*all the rest of the plant dies down, and* **fresh stems shoot up on the return of spring.**

Elicit that these plants, like the annuals, have **soft, green stems.** *Why?*

Tell that all plants with **soft, green stems,** *which die down every winter, are called* **herbs**; *and that* **trees, shrubs,** *and* **bushes** *which live for many years have* **hard, woody stems.**

II. A Piece of Oak-Stem

1. We are going to examine these woody stems of plants to-day. Let us begin with this piece of the stem of an oak-tree.

The first thing to notice is the **thick, rough, outer covering.** If I dig the point of my knife into it, I find it is **much softer than the wood** inside. It is **more like cork** than wood. It makes **a thick top-coat** to protect the tree.

Do you know what it is called? It is called the **bark of the tree.**

2. Now let us look at the wood itself. What is the first thing you observe? It is **made up of rings,** one inside the other.

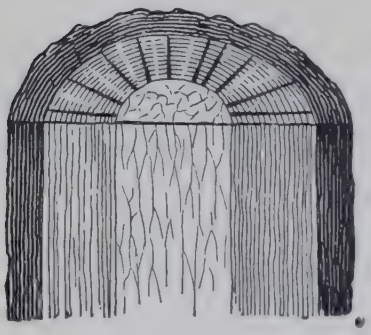
Take this knife and try to force the point of it first into the middle of the stem, and then into the outside part, just under the bark.

What do you learn? The **middle** or inside part of the stem **is much harder** than the part on the outside.

Let us see if we can find out the reason for this.

3. *Show if possible a piece of a one-year-old sapling. Tell what it is, and call attention to the* **thick, greenish-white cord** *which takes up the whole of the central part of this stem.*

Let the children examine it, and they will find that it is a **soft, pulpy kind of substance,** *with a* **hard, woody ring** *or layer* **all round it.**



Tell that this central cord of soft matter is known as the **pith,** *and that* **it is always very thick in young trees.** *It extends through the stem and branches as well.*

4. *Explain that it is through this central pith that the* **dissolved earth-food,** *which is absorbed from the soil by the roots,* **rises upwards to the leaves.**

Why must this earth-food be carried up to the leaves? Because the **leaves have to take in air-food** to mix with it, before it is fit to feed the plant.

What do we call this watery liquid which flows through plants? We call it the **sap.**

Tell that the sap, after flowing through the leaves, returns again along the twigs, branches, and stem, and that **it always flows back on the outside of the wood—between the wood and the bark.**

5. *Show a fresh cut branch of some growing tree. Strip the bark from it, and call attention to the* **sticky, watery fluid,** *which is always to be found during the spring and early summer between the bark and the wood.*

From this fluid **a new layer of woody matter is formed** during the growing season. **It is at first soft and pulpy,** but it hardens into actual wood in time. We call it the **sap-wood.**

6. The hard, woody layer round the thick pith of this little one-year-old stem is **the wood which has been formed this year.** But if it had been left to grow we should have seen next year, and each year after, **a new layer of wood formed outside this.**

These rings or layers of new wood, growing one by one, **press upon the pith all round,** till at last it becomes **a mere thread.** We can see in our piece of oak-stem only the spot in the centre of the woody rings **where the pith once was.**

But what do these rings themselves tell us? **They tell us how many years the tree has been growing,** because there is a new layer of wood formed every year.

Lead the children themselves to deduce from what they have seen—

(*a*) *That the* **centre of the stem** *is the* **oldest,** *and the* **sap-wood** *the* **newest-formed wood** *in the tree;* **the tree grows on the outside.**

(*b*) *That this central part becomes harder than the rest,* **because of the growth and pressure of the other woody rings round it** *year after year.*

Tell that the **wood in the centre of the stem** *is known as the* **heart-wood.** *It is always the* **hardest wood in the tree.**

7. *Hand a few oak-leaves round the class, and ask the children to hold them up to the light, and tell what they observe. Of course they will readily tell that these are* **net-veined leaves.** *Compare them with specimen leaves from the apple, pear, plum, and cherry trees, and with others from as many of the familiar timber trees as can be obtained—***the fir family of course excepted. They are all net-veined leaves.**

Tell that the **woody stems** *of all these trees, which have*

net-veined leaves, *grow like the stem of the oak with* **a new ring of wood on the outside year after year.**

8. *Next hand a few acorns round. Elicit that these are the* **seeds from which young oak-trees spring,** *and let the children open and examine the acorns for themselves.*

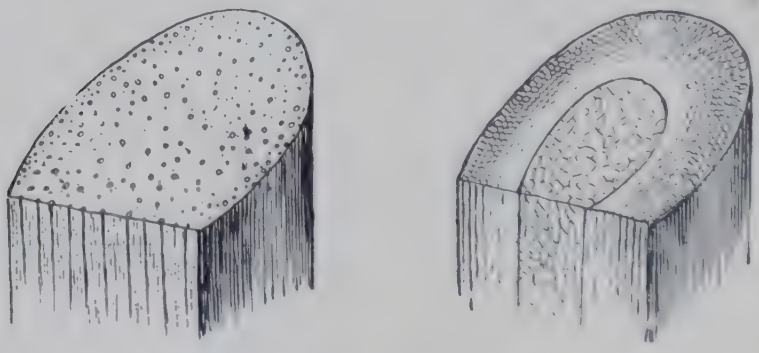
Compare the acorn with an apple-pip, or the kernels of a plum-stone, or a cherry-stone. Each of these consists of **two lobes** *or* **seed-leaves,** *and so do the seeds of all trees* **which have net-veined leaves,** *and* **stems which grow in new rings year by year.**

III. A Piece of Cane

1. *Show a piece of cane or bamboo next. A piece of sugar-cane would serve the purpose admirably.*

Notice that this stem is **hard, smooth, and shiny on the outside;** *it has* **no outer coat of bark.**

Cut through the stem, and show that there is **no central**



pith, *and that the* **wood does not grow in layers or rings** *one outside the other.*

Split the cane lengthwise, and point out that **the wood is arranged in threads or fibres.** *Tear away some of these woody fibres, and show how* **they stretch parallel,** *or* **side by side,** *through the stem from root to top.*

There is a pith, but it is mixed up with the parallel

threads of wood. **The woody fibres pass upwards through the pith.**

2. *Set one of the children to cut through the cane. He finds the* **outside very hard indeed.**

Let him press the point of the knife into the central part of the cane. He finds the **inner wood much softer** *than that on the outside.*

Explain that in plants of this kind the **new wood is formed in bundles** *of parallel fibres* **through the middle of the stem.**

These stems **grow from the inside,** the older wood is constantly being **forced outwards by the new wood** which forms inside. This explains why the outside of the cane is so hard to cut, while the central part is soft.

3. *Explain that plants with woody stems of this kind grow mostly in the hot countries of the world.*

Show a picture of the sugar-cane as a specimen. Notice the **long, ribbon-like, straight-veined leaves;** *and tell that the* **seeds,** *from which all such plants grow,* **have only a single seed-leaf.**

Sum up as before :—

(*a*) Plants which grow from seeds with **a single seed-leaf** have **straight-veined leaves.**

(*b*) The wood of the stem is arranged in **parallel bundles; it never grows in rings.**

Summary of the Lesson

1. Herbs have soft green stems; trees, shrubs, and bushes have hard, woody stems.

2. Some trees form a new ring of wood on the outside of the stem year after year.

3. The hardest and oldest wood is in the centre of the stem. It is called the heart-wood. The new wood on the outside is called the sap-wood.

4. All trees of this kind have net-veined leaves, and spring from seeds with two lobes.

5. Canes and bamboos grow from the inside. The hardest and oldest part of the stem is on the outside, and there are no rings of wood one within the other.

6. Plants of this kind have straight-veined leaves, and their seeds have only one seed-leaf.

LESSONS FROM ANIMALS

Lesson XII

THE COW, SHEEP, AND GOAT (COMPARED)

Provide for illustration a good picture showing the three animals side by side, a specimen cow's horn, a picture of a ram's head and horns, and detailed pictures of the feet, teeth, and stomachs of the animals.

I. General Appearance

1. *Show a picture of the three animals side by side, in order that the children may start with a correct notion of their relative sizes. Lead them, with the help of the picture, and by means of their own observation from day to day, to point out the most obvious features of all three as follows:—*

The cow is a **big, heavy, thick-set animal,** almost as large as a horse. The **head** is **small** compared with the great bulky body, and it has **a short, thick neck.** The **legs** are **short, thick, and strong-looking, just fit to support the heavy body.** The cow has a great bag or **udder** to hold her milk.

2. *After eliciting these points one by one, proceed to compare the animal with the sheep and goat, telling nothing, of course, but what the children fail to observe for themselves.*

These are much smaller animals; they are **about the size of a large dog.** Their **legs** are **long** and **slender,**

not thick and strong like those of the cow, because **they have less weight to hold up.**

Notice that the **goat's body** *and* **legs** *are* **more strongly built** *than those of the sheep. Tell that* **the goat is a mountain animal.** *It must be strong and active* **to climb the mountains** *and* **spring from rock to rock.**

II. The Head

1. *Call attention to the* **broad, flat forehead,** *and the* **square muzzle** *of the cow, and compare with the heads of the sheep and the goat, both of which are* **rather pointed.**

Notice that all three animals have **large eyes,** *which are* **placed at the sides of the head** *and not in front,* **ears that can be raised erect** *in an instant, and* **wide-open nostrils.** *Elicit that they are all* **timid, gentle** *creatures*

—a sheep will begin to bleat and run away if only a little child goes near it.

2. *Tell that in their wild state they have many enemies among the fierce, flesh-eating animals, and that, as they cannot fight them, they have only their legs to depend upon for safety.*

Those large eyes **at the sides of the head** enable them to **see well in every direction**; the **large, erect ears** can **catch the faintest sound**; and the **wide-open nostrils** help them still further by **scenting their**

enemies even at a great distance. They thus get timely warning if any danger approaches, and are able to make off at the top of their speed.

Lead the children to tell that the animals in running must get out of breath, and that they require to breathe hard to take in plenty of air. This will readily suggest another purpose of those wide-open nostrils.

3. Now look at the picture again, and you will notice something on the head of the cow and the goat which you do not see on the sheep's head.

What do I mean? The cow and goat have **horns**; the sheep has not.

Remind the children of the earlier lesson on the sheep (Stage I. Lesson XVII.), and elicit that all sheep are not like the one in the picture; that the **ram,** *or* **male sheep,** *has a pair of* **large, twisted horns;** *and that some kinds of sheep are all horned—*ewes as well as rams. *Show a picture of one of these.*

It would be well now to let the children compare the horns of the three animals, although as this is not a lesson on horns, too much should not be made of it, and the comparison should be briefly and rapidly made.

(*a*) The **goat's horns** spring from the top of the head and **curve backwards;** the horns of the **sheep** and **cow** stand out **on each side of the head.**

(*b*) The **cow's horns** are **smooth on the outside;** but the **horns of the sheep** and **goat** are **crossed with ridges,** which give them a rough, wrinkled appearance.

If a specimen cow's horn can be obtained, let the children examine it, and discover for themselves that the smooth outside part is nothing but a **sort of sheath,** *to cover the* **hard, bony core inside.**

III. The Covering

1. *Notice next the coverings of all three animals.*

The **cow** has a **thick skin** or **hide** covered with **short, coarse hair;** the **sheep** has a **thick coat of wool;** and the **goat** also has a thick coat, but it consists of **long hair,** not wool.

Point out the fitness of each covering for the needs of the animal. The sheep and goat require a warm coat, for **they are exposed,** *night and day,* **to all weathers.**

Picture the goat in the cold, bleak mountain air, and the sheep sleeping on the damp grass on some hill-side. Tell that in cold northern lands the hair of the cow **becomes thick and shaggy,** *almost like coarse wool.*

2. *Notice next the* **cow's long tail,** *with its* **thick tuft of hair at the end.**

Who has seen the cow on a hot summer day whisking her tail in all directions? Why does she do this?

Explain that flies and other insects are very troublesome to her in hot weather. They settle on her head and neck and body, and worry her.

She uses her long tail with its tuft of hair to drive them off.

Point to the short tails of the sheep and the goat. Explain that the **flies cannot get to the skin** *through their thick coats.*

These animals **do not want a long tail** to whisk them off.

IV. The Feet

Lead the children to describe, point by point, the structure of the sheep's foot, as it was given in Stage I. Lesson XVII., assisting of course where necessary.

That done, produce if possible a specimen cow's foot, and let them discover from actual observation that the two **are built on exactly the same plan.**

Of course in the absence of the real thing a picture must be used; but even with it a good picture will always be helpful for reference.

Show and explain further that the **feet of the goat** *are* **cloven hoofs,** *like those of the sheep and cow, and then proceed to point out how each is modified to suit the wants of the animal.*

Examine the under part of the cow's foot. Notice the **broad tread,** *and explain that* **the two toes spread out** *with the weight of the animal in walking.*

Contrast this with the **small foot** *and* **close-fitting toes**

of the sheep and goat. Point out that the cow's natural home is **on the low, grassy plains** *and* **meadows**; *that* **sheep feed mostly on the hill-sides**; *and that* **goats live among the rocks** *and* **mountains.**

Show that the small, compact foot, which **fits the goat for climbing** *and* **springing from rock to rock,** *would be altogether as unsuitable on the damp, soft soil of the meadows, as the broad, spreading one would be on the smooth, slippery surface of the rocks.*

V. Habit of Feeding

Produce the sheep's skull, or show a picture where the real thing cannot be obtained, and proceed to elicit all that was taught about it in the former lesson, assisting as usual where necessary.

Let the children point out the **row of sharp cutting teeth in front** *of the lower jaw, with the* **hard pad instead of teeth opposite,** *and the* **large, strong grinders behind.** *Lead them also to describe the* **double movement of the jaw** *peculiar to the chewing animals.*

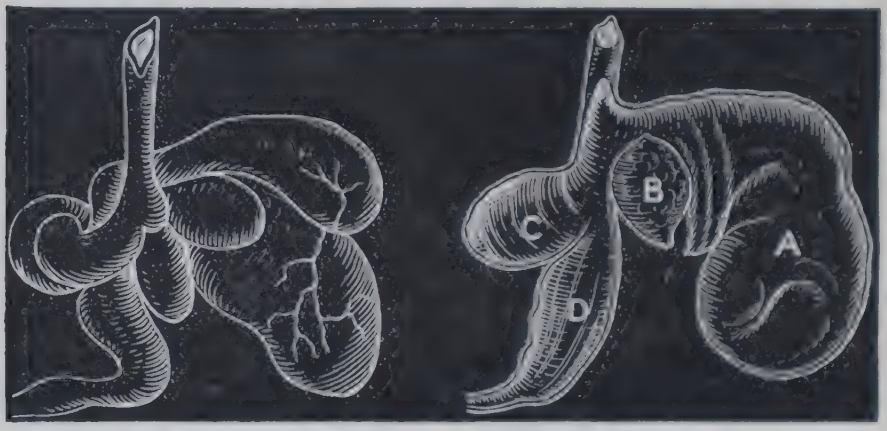
Proceed next to describe the **soft, movable lips,** *and the* **long, flexible tongue,** *and elicit the purpose of these in gathering up and* **tearing off the grass in tufts** *ready for swallowing.*

Lastly, show by means of a picture or a black-board sketch the connection between all this and the arrangement of the **stomachs of the animal,** *and so lead the children to describe its peculiar mode of feeding by* **chewing the cud.**

The cow and the goat feed in precisely the same way. **They also chew the cud.** The **mouth, tongue, teeth,**

and **stomachs** of these animals are **exactly like those of the sheep.**

All animals with cloven hoofs chew the cud except one. Do you remember which one that is? Yes; the pig.



Summary of the Lesson

1. The cow, sheep, and goat are cud-chewing animals, with a pad instead of teeth in front of the upper jaw, large grinding teeth behind for chewing, and four stomachs.

2. Their eyes, ears, and wide-open nostrils point them out as timid animals.

3. The goat is a mountain animal. It is specially fitted for climbing and springing from rock to rock, for it is strong, active, and sure-footed.

4. The broad spreading hoof of the ox fits it to live on the low meadows and grassy plains. The sheep's natural home is on the hill-sides.

5. The thick hide of the ox protects it against the damp soil of the meadows, and the woolly fleece of the sheep and the hairy covering of the goat are their protection against the bleak biting air of the hills and mountains.

6. The ox has a long tail which it uses to drive off the flies that settle on its body. The sheep and goat have no need for such a tail.

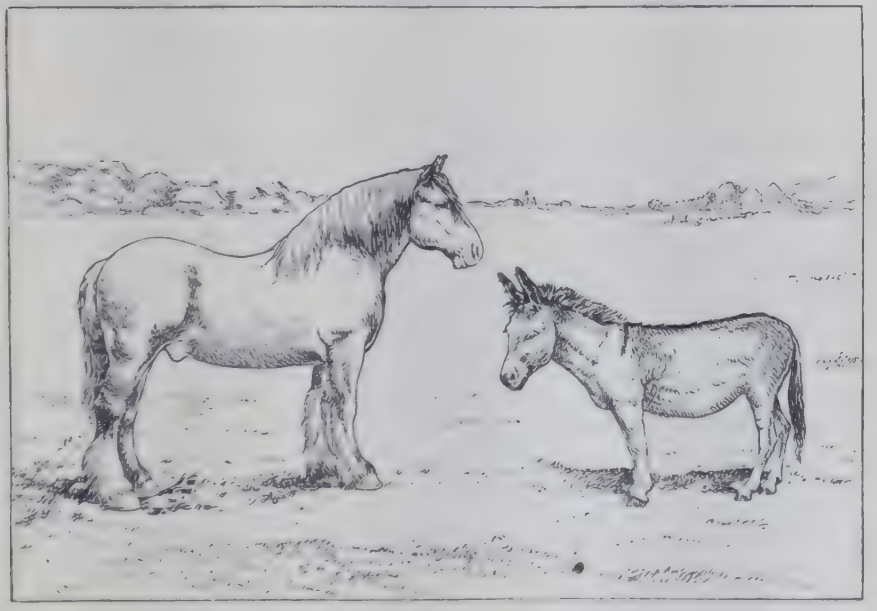
Lesson XIII

THE HORSE (COMPARED WITH THE DONKEY) (1)

The teacher should be provided with a good picture showing the horse and donkey side by side, or models of the two animals if they can be obtained ; specimens of horse-leather and parchment, and pictures showing details of teeth, mouth, and hoofs. A horse's bit should be borrowed if possible for the lesson.

I. Introduction

Introduce the picture showing the horse and donkey side by



side, or better still, place on the table models of the two animals in relative sizes, if they can be obtained.

Commence the lesson by leading the children to tell, with the help of these, and from their own observation, such points as the following :—

The **horse** is a big, strong animal, **larger than the cow.** He is **quiet, gentle, obedient,** and **very sensible;** he is one of the most useful of all our domestic animals.

Compare the **donkey** *with the* **horse** *in these respects. Notice that both have* **the same general appearance,** *except that the* **donkey is smaller** *than the horse. Tell that the donkey is quiet, gentle, obedient, and sensible too* **if he is well treated;** *but some people are very cruel to him,* and then he often becomes **stupid** and **obstinate.** But that is not his fault.

Remind the children that we do not eat the flesh of these animals, nor do they supply us with milk as the cow does.

The horse and the donkey are useful as **beasts of draught and burden.**

Elicit that there are several different kinds of horses—**cart-horses, carriage-horses, hunters,** *and* **race-horses**—*and each is useful in its own way. Explain* **mare, colt, foal, filly.**

II. Body, Head, and Neck

1. **Build of Body.**—*Turn now to the model or picture of the horse, and notice the following points, leading the children to discover as much as possible for themselves, and telling only where they fail.*

The body is **long** and **rounded,** with a **deep, broad chest,** a **curved back,** and **powerful haunches.** It is built for strength and endurance.

Picture a horse tugging a heavy load along. It is those **powerful haunches** *that do the work. Notice* **the hollow** *in the middle of the back; it makes an easy and secure seat for his rider.*

Lead the children to tell the purpose of the dog's deep, broad chest (Stage I. Lesson XVI.).

The **horse,** like the dog, is **a running animal.** He would not be able to run, and draw heavy loads, if he had a narrow chest and small lungs. How hard he breathes

while running. That is to keep his big lungs **filled with plenty of air.**

Elicit and show that **the donkey's body,** *although smaller, is in all these respects* **like that of the horse.**

2. **The Head and Neck.**—*Lead the children to continue their observations :—*

The **head** is **long** and **somewhat pointed** towards the muzzle ; the **jaws** are especially **long**. The **neck** is **long** and **arched,** and its upper edge is covered with hair which we call a **mane.**

Picture the horse and donkey in the field, and lead the children to explain the **advantage of a long head and neck** *to these grazing animals. Compare them with the cow in this respect.*

Note next the difference between the manes of the two animals.

The hair of the horse's mane is **long and fine,** and

flows over the neck ; that of the donkey is **short and coarse,** and **stands up** almost like **bristles.**

3. **The Eyes.**—In both animals the **eyes** are **large** and are **placed at the sides of the head,** and not in

front. What do we learn from this as to the nature of the animals?

Lead the children to prove from their own observation that both the horse and the donkey are **timid animals** *even in their domestic state. They will quickly* **take fright** *and* **shy,** *if they see anything strange. Show from this the* **purpose of the blinkers,** *which they are made to wear over their eyes.*

4. **The Ears.**—The **ears of the horse** are **short, erect,** and **pointed;** those of the **donkey** are **much larger.** Both animals are very sharp of hearing; they "prick up their ears" at the least sound. **All timid animals do so.**

A bad-tempered horse **throws his ears back.**

5. **The Nostrils,** like those of **all timid animals,** are large, fleshy, and open. They have a **keen sense of smell,** and they are also **of great service in running.** Why?

Compare with the cow, sheep, and goat.

III. Covering and Tail

1. **The Covering.**—*Compare the covering of the two animals next, leading the children to point out that* **the horse** *has* **a smooth, glossy coat of fine, short hair,** *while the* **donkey's covering** *is a* **rough, shaggy coat of coarse, thick hair.**

Elicit, or tell if necessary, that the horse's coat grows thicker and longer in the winter, but on the return of spring his master has it clipped close again, and frequently washes and scrubs him down **with a curry-comb.**

The donkey's coat grows too, but nobody thinks of clipping it or taking care of it. The poor donkey's life **is a rough, hard** one compared with the life of the horse.

Notice next the colour of the coat, and lead the children to tell that there are **white, black, bay, dun, grey,** *and* **dappled horses.**

The **donkey's coat** is always **grey** with **one dark stripe across the shoulders** and another **along the middle of the back.**

2. **The Skin.**—*Tell that the skin or hide of the two animals is as different as their covering.*

The **horse's skin** is **thick,** but **not so thick and hard** as the cow's hide. It is **sleek** and **soft to the touch.** When the animal is dead its skin is made into **useful kinds of leather** for covering chairs and sofas, for making harness, and for stout, strong driving-gloves.

The **donkey,** to make up for its thick, rough coat, **has a thinner skin** than the horse. It is made into a **thin kind of leather called parchment.**

Show specimens of these leathers.

3. **The Tail.**—The actual tail of the horse and the donkey is **short, thick, fleshy,** and **pointed.** The horse's tail is **entirely covered with long, stiff hairs,** which hang down to the ground. The donkey's tail **is covered with short, coarse hair** like that on the body, and **it has a tuft** of long hair at the end.

Summary of the Lesson

1. The donkey, although smaller than the horse, is like it in build.

2. The horse has a smooth, glossy coat and a long mane ; the donkey's coat is rough and shaggy, and the mane stands up like stiff bristles.

3. The horse has a tail of long stiff hairs which hang down to the ground ; the donkey has a tuft of hair at the end of its short fleshy tail.

4. Both are running animals.

5. Both have erect pointed ears, but the donkey's ears are larger than those of the horse.

6. In both the nostrils are wide and open, and the eyes are placed at the sides of the head. They are timid animals.

Lesson XIV

THE HORSE (COMPARED WITH THE DONKEY) (2)

I. Introduction

1. *Show the picture or the models of the two animals once again, and commence with a few minutes' rapid questioning on the last lesson.*

Let the few questions asked be framed in such a way as to bring out the comparison, point by point, between the two animals, so far as it has been dealt with already.

The tail of the rough, shaggy-coated donkey is altogether different from that of the sleek-skinned horse. Why?

Lead the children to think of the tormenting flies and other insects in the hot summer weather, and they will readily answer this question.

2. *Compare with other animals which have been dealt with in former lessons.*

Lead them next (1) *to describe the structure of eyes, ears, and nostrils, and* (2) *to explain the connection between this structure and the nature of the animals.*

Why are the donkey's ears so much larger than those of the horse?

Why are blinkers placed over the eyes of the horses and donkeys which we pass in the streets? To prevent these timid animals from seeing anything that might frighten them, and cause them to shy.

Elicit, step by step, that these side shutters shut off the view of everything on both sides of the animal, so that it can only see straight ahead; that the driver in the cart or waggon behind guides and directs it by means of the reins; and that, as he is

sure to choose the best and clearest part of the road, there is nothing to frighten the animal and make it start.

Show how necessary this is by picturing what damage a runaway horse would do in the streets.

II. Legs and Feet

Let us now see what else there is to learn about these two animals.

1. *Note that in both animals* **the upper part** *of all four legs is* **short, thick,** *and* **strong-looking,** *the* **lower part**

long *and* **slender**—*the very best form of legs for* **running animals.**[1]

The **foot** is all in **one solid piece**; it is really **a single toe.**

Compare with the other toe-walkers, the cat, dog, sheep, and cow.

This toe is enclosed in **a horny case** or **hoof,** like the hoof of the cow; except that **it is not cloven.**

[1] *N.B.*—The general build of the legs will be quite sufficient at this early stage, without entering into any details or peculiarities of structure. These can safely be left for the present.

2. *Show a picture of the under part of the hoof, or make a sketch of it on the black-board.*

Notice that it is **hollowed out** *from below; that there is*

a thick, fleshy lump, *called the* **frog,** *in the middle of the hollow, and* **a broad rim round the edge.**

Point out the difference in the shape of the two hoofs.

The **horse's hoof** is **almost round; that of the donkey** is more **oval** than round.

3. *Show a horse's shoe, and explain that this is made to fit the rim of the hoof.*

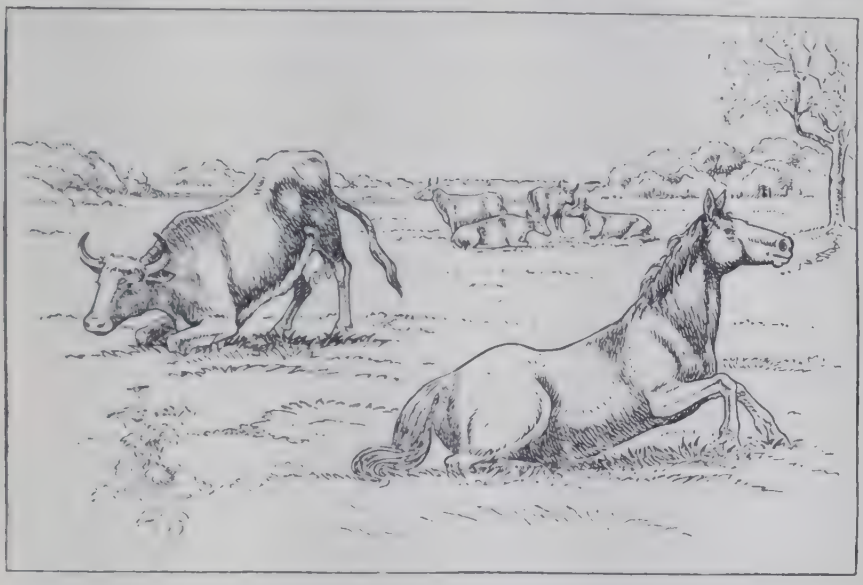
It is nailed to the hoof without causing any pain, **because there is no feeling in that hard, horny case.** The farrier can cut and trim the hoofs, just as we cut and trim our nails; for both are made of the same kind of horny substance.

Remind the children that these animals in their wild state **live on the smooth, grassy plains,** *and their hoofs (like our nails) grow as quickly as they wear out.* **They do not require shoes.**

Our domestic horses and donkeys have to travel and draw heavy loads **over rough, stony roadways,** and their hoofs would wear away more quickly than they can grow. This is why **we nail iron shoes to them.** It is to preserve them—to prevent them from wearing away too fast.

Tell that wild horses and asses, when they cannot escape from their enemies by running away, fight them by kicking with their hind-legs. This is their only means of defence.

It will interest the children to learn that in some lands oxen are used, as we use horses and donkeys, to draw carts and waggons, and that iron shoes, like those which we see



on horses' feet, are nailed to their hoofs, to keep them from wearing out on the rough, stony roads.

4. *There is one other point worth noticing in connection with the legs.*

Ask the children whether they have ever watched a cow and a horse get up on their feet after they have been lying or resting on the grass. If they have not, tell them to keep their eyes open next time, and they will see that **the cow kneels on her fore-legs,** *and* **gets up on her hind-legs first,** *while* **the horse throws out the fore-legs first,** *and raises himself on his hind ones afterwards.* **The donkey rises in the same way as the horse.**

III. Teeth and Habit of Feeding

Lead the children to describe briefly and rapidly the nature of the cow's teeth, and then proceed by means of the picture to compare them with the teeth of the horse and the donkey.

1. **Grinders.**—*Notice first the rows of* **great square teeth** *in the hinder part of each jaw, and let the children tell the purpose of such teeth.*

These teeth are exactly like those of the cow, and **are meant for chewing.** The food of the horse and donkey (like that of the cow) is **entirely vegetable**, consisting of grass, hay, corn, thistles, etc.

With great grinding teeth like these what would you expect to find, as regards the movements of the jaw itself? **The jaw should move sideways** as well as up and down.

Why? Because the sideway movement causes the rough edges of the teeth to rub against each other, and so **grind the food,** as corn is ground between the rough edges of the mill-stones of a mill.

Tell that the **jaws of the horse and the donkey** *actually* **have the same double movement** *as we noticed in the other chewing animals.*

2. **Cutting-Teeth.**—*Now notice the front of the mouth.*

The horse has **no pad in front** of the upper jaw as the cow has. There are **six sharp cutting-teeth in front of each jaw.**

Tell that the horse and the donkey **do not chew the cud.** *They nibble off the grass with their sharp front teeth, and* **chew it at once** *before swallowing it.*

They have **one stomach,** *not four as the cow has.*

Their **thin, delicate lips** have a fine sense of touch, and **help the animals to choose their food.** The **horse** is **very particular** over his food, but **the donkey** will leave everything else **for a few thistles.** Both

animals are very dainty over the water they drink. **They will only drink clean water.**

3. **The Bar.**—*Notice next the pointed tusks on either side of these cutting-teeth, and then call attention to the* **wide gap** *or* **space** *between them and the grinders.* **This space is known as the bar.**

Show a **horse's bit,** *and tell its use. Explain that when the bit is put into the horse's mouth,* **it fits into this space** *without causing any inconvenience.*

Point out that if the teeth were placed all round the jaws as ours are, it would be impossible to put the bit into the horse's mouth—at least he would not be able to close his mouth with the bit in it.

Summary of the Lesson

1. The horse and the donkey have solid hoofs.
2. The horse's hoof is round ; that of the donkey is oval.
3. The thick, fleshy lump in the middle of the hoof is called the frog.
4. The horse and the donkey have cutting-teeth in front of both jaws, not a pad like that of the cow and the sheep.
5. The space between the tusks and the grinders is called the bar. The bit fits into the bar.
6. Both animals have large, strong grinding-teeth for chewing their food.
7. They have one stomach, not four. They do not chew the cud.

Lesson XV

THE RABBIT

Provide for illustration a tame live rabbit if possible, and a wild rabbit from the poulterer's (dead of course). Have in readiness a good picture of the animal, and sketches showing details of the structure. A carpenter's chisel will also be required.

I. Introduction

Show the picture, and ask for the name of the animal.

Yes; this is a picture of a rabbit. Did you ever see a rabbit alive? Oh, you keep rabbits at home, do you?

But those you keep are **tame rabbits,** and live in a hutch. This is not the picture of a tame rabbit, but **a wild one.** Wild rabbits are found **in the woods and fields** in all parts of the country. They are pretty little animals.

Let us see what we can learn about them.

II. General Appearance

Produce the tame, live rabbit, and lead the children, step by step, to notice the chief points in the animal as follows:—

1. **Size, Shape, and Covering.**—*Elicit that the rabbit is about* **the size of the cat;** *that it has a* **long body** *and a* **small head;** *and is covered like the cat with a* **thick, soft, warm coat of fur.**

Lead the children to tell that the pretty tame rabbits which they sometimes see in hutches, are of various colours —black, white, grey, and brown—and explain that the **wild rabbits** *are always* **grey** *or* **brownish-grey.**

2. **Eyes and Ears.**—*Call attention to the ears. They are* **long** *and* **broad,** *and will either* **stand upright** *or*

hang down. The rabbit can easily move its ears. *Notice too the* **large, bright eyes.** *Point out that they are placed one* **on each side of the face,** *not in front as ours are.*

What do these eyes and ears tell us? They tell us that the rabbit is a **very timid,** gentle animal. It **cannot fight** to defend itself as dogs and cats do. It **has to be watchful** to keep out of danger.

The children will readily tell that the big, wide-open ears catch the slightest sound; and that those eyes at the sides of the head enable the animal to see all round it at once. Note that as soon as it is out of danger **its long ears droop down** *on its neck; but at the least sound* **up they go again to listen.**

3. **Whiskers.**—*Notice next the long, stiff hairs or bristles which stand out on each side of the mouth.*

What other animal has whiskers like these? The cat.

What name do we give them besides whiskers? We call them **feelers.** Why? Because the animal uses them **to feel its way about when it is too dark to see.**

4. **Legs and Feet.**—*Lead the children to tell that as these animals cannot fight their enemies, they must run away and hide themselves, and this will show the need of strong legs.*

Tell that rabbits can **run very fast.** *Call attention to the* **hind-legs**—*they are much* **longer and stronger** *than the fore-legs. The rabbit's running is more like leaping, for* **it leaps along on these strong hind-legs.** *As it runs it seems to bob and jump about,* **because its legs are not all the same length.**

Picture the rabbits as they are often seen in the country fields, darting away out of sight in leaps and bounds, **the little white tails bobbing up and down** *as they go.*

5. Have *the feet of the animal* examined next.

The **soles** of the feet are **hairy;** this helps them in

their running.

Each foot has **four toes,** and the toes are armed with **thick, blunt claws.**

What use do cats and other animals make of their claws? They **fight and scratch** with them.

But rabbits are not fighting animals. What can they want with strong claws?

Tell that these animals use their claws for digging in the ground.

III. Mouth, Teeth, and Food

1. **Chisel-teeth in front.**—We have learnt all we can of the rabbit by looking at it. Let us now examine it a little more closely. I am going to show you **its mouth and teeth,** for they will tell us what kind of food it eats, and then we shall easily learn something about its habits.

Point out in the first place the peculiar form of the **upper lip,** *with its* **long cleft** *dividing it into two halves,* **both movable.**

The mouth itself is small, and the teeth are different from those of most other animals. The **four front teeth,** two in the upper and two in the lower jaw, are long, broad, flat, and very sharp at their edges. **They are,** in fact, **four sharp chisels.** We often call them **chisel-teeth.**

Point these out in a good picture of the skull, or, better still, have a wild rabbit from the shop for illustration.

Show a chisel, and illustrate its use. It cuts off pieces of wood in chips.

Tell that the rabbit uses these four front teeth **to chip off its food in pieces.**

We say it gnaws or **nibbles its food,** and we call it a **gnawing animal.**

2. **Mouth made for gnawing.**—*Call attention once more to the cleft in the upper lip.*

Why should the lip be split like this? Let us see.

Point out that we ourselves could not gnaw things as the rabbit does, although we also have four flat chisel-teeth in front.

How is this? Our lips would be in the way; they would get cut and torn by the hard substance, and so would our mouth and tongue.

The rabbit's teeth are **made for gnawing;** they stand out well in front; and it is **to help the animal in its work** that the upper lip is split in two, so that **the two parts may be drawn back** out of the way, when it is gnawing anything very hard.

Show too how the mouth itself is protected. Call attention to the **white patch of thick, hard skin on the tongue,** *and the* **horny ridges** *which form the* **roof of the mouth.** *Point out that even the inside of each cheek is protected by* **a tuft of hair.**

3. **Grinding teeth behind.**—*Have the jaws examined for the other teeth now. Notice the long space in both jaws between the chisel-teeth and the next.*

The rabbit has only two kinds of teeth. In the back part of each jaw are **the grinding teeth.** There are **six**

of them in the upper jaw and **five** in the lower. They are large square-looking teeth, with **sharp, rough, rasp-like ridges,** for the purpose of grinding the food which the chisel-teeth have chipped off in pieces.

The jaw moves not only up and down, but backwards and forwards, and from side to side.

4. **Food.**—Now let us notice the kind of food which these animals find to eat in the woods and fields. They eat the farmer's **corn** in the corn-fields, and they nibble and gnaw his **turnips** and other roots. They are also very fond of **the bark of young trees.** They gnaw off the bark as far as they can reach, standing on their hind-legs, and in this way do much damage.

IV. Chisel-Teeth always Sharp

1. *Picture the cat, as we often see her, scratching with her claws on the wooden fences, the trees, and even the legs of the tables and chairs.*

Why does she do this?

Explain that this is her way of keeping her claws sharp and in good order. Without sharp claws she would not be able to catch the mice. Tell that the **rabbits gnaw the hard trunks of the trees** *for the very same purpose—merely* **to keep their working-tools in good order.** *Without sharp chisel-teeth to gnaw their food these animals would starve.*

2. *Show the carpenter's chisel, and lead the children to tell that, when the workman has been using it for some time, its edge gets blunt, and he has to sharpen it.*

What becomes of the chisel at last? It gets worn away with the work it does.

Point out that if the hard steel of the chisel wears away with its work, these **chisel-teeth must wear away** *too in time; and then proceed to explain Nature's provision for this.*

3. The under part of the tooth is made of **much softer**

substance than the front or outer part. Therefore as the teeth are used **the softer part wears away** more quickly than the hard outer part, and so **the edge is always kept sharp**.

But even that hard steel chisel of the carpenter wears away altogether in time, and he has to get a new one.

Explain that the rabbit never wants new teeth, because **as fast as they are worn away at the edges, they grow at the roots,** *and are pushed up from the jaws, and so they are always kept the same length.*

Summary of the Lesson

1. The rabbit is a timid, gentle animal, without any means of defending itself.

2. It is provided with sharp ears, and large bright eyes at the sides of its head, and it can run very fast.

3. Its hind-legs are longer and stronger than the fore-legs They are made for leaping.

4. The rabbit is a gnawing animal. It has chisel-teeth in front, the upper lip is split, and the roof of the mouth is protected by hard, horny skin.

5. The more the chisel-teeth are used in gnawing the sharper they are.

6. They grow at the roots as fast as they wear away at the edges.

Lesson XVI

THE RABBIT AND HARE (COMPARED)

The teacher should be provided with a good picture showing the hare and the rabbit side by side, the picture showing details of structure as used in the last lesson, and another picture showing a section of the rabbits' warren.

I. Introduction

Introduce the new lesson by leading the children to tell all

they can of the nature and general build of the rabbit. Be careful to show how the nature and habits are dependent on the structure.

Here we have a timid, frightened little animal, with no means of defending itself against its numerous enemies. To make up for this it has a **pair of large, wide-open ears,** and its **eyes** are placed **at the sides of the face.** It can easily erect its ears, and turn them in any direction to catch the faintest sound, and the eyes can see readily on all sides.

In this way it gets timely warning of all danger, and then it is able to make use of its swiftness in **running** or rather **leaping away.**

It was intended to live on roots and other vegetable food, and it is provided with **chisel-teeth** for nibbling or **cutting away its food in chips,** fit for the grinding teeth to chew.

Lead them next to talk about the **thick, warm covering of fur.** *Show that this is just the sort of coat to fit the animal* **to live in the open air.** *The* **colour of the fur,** *too, is just the* **colour of the ploughed fields,** *over which it loves to scamper.*

The paws are made for **scratching** *and* **digging** *in the earth, and the* **whiskers** *are for the purpose of* **feeling its way** *in the dark, when the eyes are no longer of use. All this should be carefully elicited step by step.*

II. Rabbits at Home

1. In all parts of the country rabbits live wild in the fields and woods. They are very frightened, timid creatures, and like to hide away out of sight in their homes.

But their home; what is it? Rabbits make their homes **underground.**

How do they do this? They use their **strong feet** and **stout, blunt claws to burrow** or **dig holes in the ground.**

They always choose a sandy spot, often on the sunny side of a hill, where it is sure to be warm and dry, and here they set to work. They dig easily in the sandy soil with their feet, and make **long winding passages** or **burrows** under the ground.

They live together in great numbers, and make their burrows **side by side.** A **great many burrows** close together form **a warren.**

Tell that, once in their burrows, the **rabbits are safe** *from all such large enemies as* **dogs** *and* **foxes,** *because they make their long, winding holes only* **just large enough for themselves,** *and those big animals cannot make their way into them.*

2. *Explain that they have other enemies* **quite as terrible,** *although smaller even than they themselves are. Show pictures of the* **ferret** *and* **weasel.**

These fierce animals, which are a kind of small wild-cat, can easily make their way into the burrows. How do the rabbits protect themselves against them?

Tell that they always make their burrows **with two or**

more entrances, *so that if any such enemy should come in at one hole, they would be able to* **escape by another.** *Remember they cannot fight.*

3. Let us have a peep at the rabbit at home. Here, at the end of one of those long passages, the mother rabbit prepares a nice **snug bed** of grass, hay, or straw, and to make it still warmer and more cosy she covers this **with**

fur from her own body. This is where the tiny rabbits are born and kept safe.

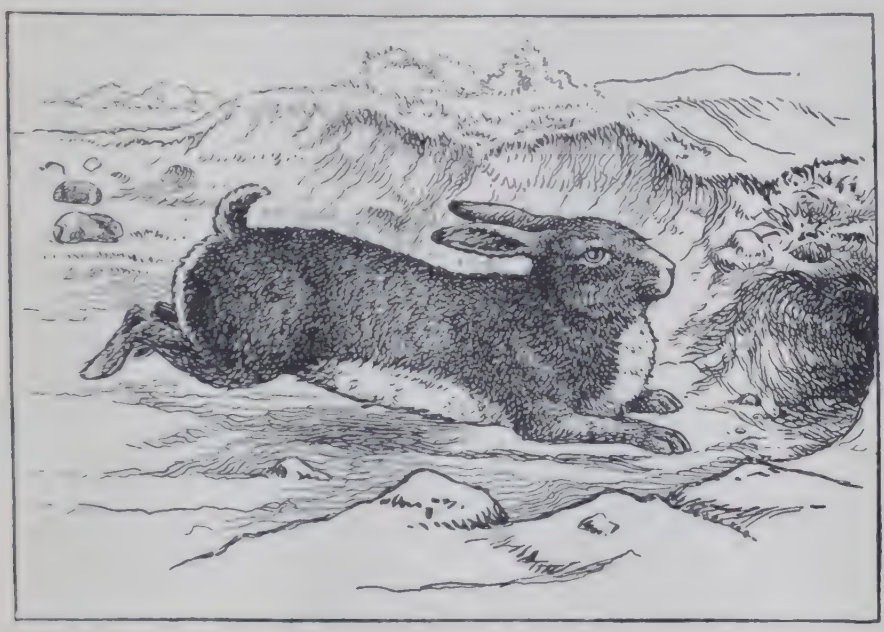
How do the rabbits get on in the dark? for, remember, it is **dark in those underground passages.** Their **feelers serve them instead of eyes,** so that they know where they are going.

4. *Tell that they are rarely seen abroad during the day, certainly never far from their burrows; but* **after dusk,** *and* **in the early morning,** *they love to scamper over the fields. The* **colour of their fur,** *which is very like the colour of the*

earth, **serves to hide them from their enemies,** *and their sharp ears and eyes tell them if any danger approaches.*

Picture them scampering off into the corn-fields and turnip-fields.

Why do they go there? **To get their food.** They



do much damage by gnawing the farmer's crops, and the farmer often takes his gun in the morning and evening, and makes short work of the intruders.

III. Hares and Rabbits

1. **General Build.**—*Show the hare and the rabbit side by side, and proceed to elicit, one by one, the points in which the two animals resemble each other.*

In both animals the body, head, and ears **have the same general shape;** the **eyes** are large, and are **placed at the sides of the head;** the teeth are the same, and there is the same split or **cleft in the upper lip**—therefore both are **gnawing animals;** the **hind-**

legs are much **longer and stronger** than the fore legs; the **feet** are **soft hairy paws** with four toes, and each toe is armed with a strong blunt claw; and the covering in each case is a coat of **fur.**

The children will readily note such points as these.

We find then that the two animals are alike in shape and general appearance. But I want you to look again, and tell me whether they are alike in their nature.

Can you tell this too by looking at them? Yes; they are **both timid animals,** and unable to fight to defend themselves.

How did you find that out? Their **ears** and **eyes tell us that.**

Why should timid animals have ears and eyes like these? They have to be **very watchful—always on the look-out for danger.**

Picture hares and rabbits in the fields in the act of listening. They can turn their ears backwards or forwards, or from side to side, to catch the sound from any direction. The **hare** *is* **even more watchful** *and alert than the rabbit. It is a very difficult matter to get near a hare.*

Lead the children to deduce from this the necessity for **the long hind-legs,** *which are so much longer and stronger in the hare than in the rabbit. All timid defenceless animals are very swift of foot;* **the hare is one of the swiftest of animals.**

2. **The Fur.**—The **fur of the hare** is **soft** and **curly,** almost like wool; the **rabbit's fur** is **smooth,** and not in the least curly. The colour too is different. The back and sides of the hare are **reddish-brown mingled with black,** the **under part** of the body is **almost white.** The rabbit's fur is a greyish-brown colour.

3. **Habits.**—*Remind the children of the gregarious nature of the rabbit, not of course using the word gregarious itself, but leading them to describe its* **burrowing habits,** *and its life*

underground—**immense numbers living together in one warren.**

Tell that **the hare is not fond of company,** *and is* **not a burrowing animal.** *It* **does not live underground.** *It chooses a quiet spot, where the grass and ferns are thickest, and there it makes a slight hollow*—**a sort of**

nest—*just big enough for itself and its mate. This is its home, and this is where its little ones are born—three, four, or five at a birth.*

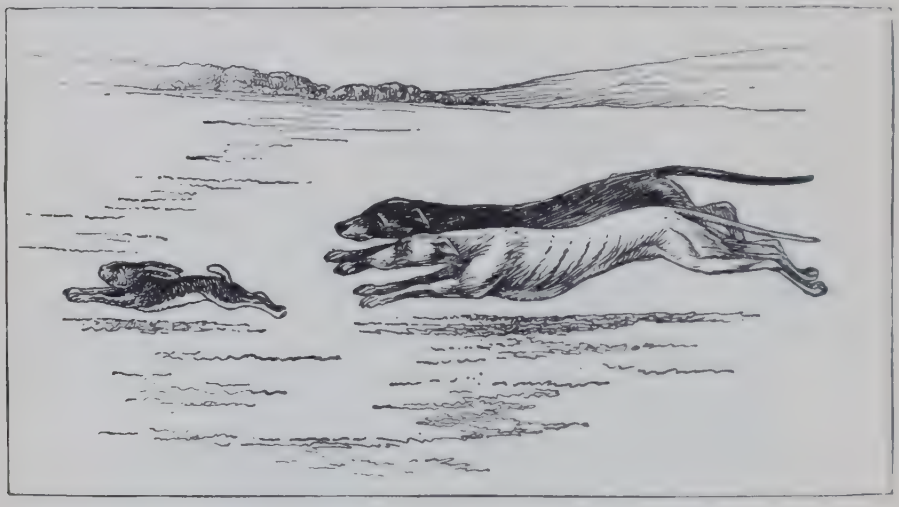
We call this nest **the form,** because **it takes the shape or form** of the animal itself.

Remind the children that the hare is much worse off than the rabbit, for it has no underground burrow into which it can rush for safety from its enemies; and so lead them to see **the need for greater speed in running.**

The hare is hunted by very swift dogs called **greyhounds.** These dogs **chase their prey by keeping it in sight,** and at last run it down exhausted. It is really a

race between the hare and the hounds; but **the hare is running for its life.** We call this sort of hunting **hare-coursing.**

Describe the hare's clever trick of dodging the dogs **by doubling on them.** *In its headlong speed it manages* **to turn all of a sudden,** *and run off in another direction.*



The dogs cannot do this so well, and they dash ahead in the same course for some time before they can turn. This gives the poor hare a fresh start, and often saves its life.

Summary of the Lesson

1. Rabbits use their strong blunt claws for burrowing in the earth.

2. They live in burrows to be safe from their enemies. They come out to feed.

3. Hares do not live together in great numbers, and do not burrow.

4. They make a nest or "form" among the grass and ferns.

5. The hare is larger than the rabbit. It is one of the swiftest of animals.

6. Hares are hunted with very swift dogs called grey-hounds.

Lesson XVII

THE MOLE

The teacher will require a good picture, or a prepared specimen, of the animal. (A living specimen is very difficult to obtain even in the country, or that, of course, would be better than either.) In any case the details of the structure must be well shown, and there must be a good picture of the mole's "fortress."

I. Life and Habits

1. *Show a picture of the mole, or, better than that, a prepared*

specimen, and better still (where it can be obtained) a live mole in a cage.

Tell the name of the animal and proceed as follows:—

Here is a little animal about **the size of a small rat.** It lives wild in most parts of the country, and yet it is **very seldom seen alive.**

Explain that **the mole's home is underground,** *and at the same time point out that rabbits also live underground, but they are often seen frisking about in the fields.*

Why do we so frequently see rabbits? They come out of their burrows morning and evening **to feed.**

What is their food? Where do they find it?

In this way lead the children to tell that the rabbit burrows in the earth to make itself a snug home, safe from its enemies, where it can live and rear its young; but that **it must come to the surface to feed,** *and loves to scamper over the fields.*

2. *Now tell that the mole chooses an underground home, not simply because it is* **safe, snug,** *and* **cosy,** *but* **because the food on which it lives is underground too.**

It is **born** underground; it **lives, eats, drinks, works,** and in all probability **dies** there.

What sort of food do you think it can find underground?

Excite the curiosity of the children, and then tell that—

It is a **fierce, hungry little creature,** and would not be satisfied with such food as the rabbit eats. It **catches other little animals,** and eats them.

What sort of animals can we find in the earth?

What have you often found when digging in the garden?

Lead the children in this way to think of **worms** *and* **grubs** *that live in the ground. Explain that these are the* **natural food of the mole,** *and it is* **because he lives on such food** *that he makes his home in the earth.*

II. How fitted to live Underground

Proceed next, with the help of the picture, the animal itself, or both, to call attention to its structure, leading the children to notice point by point, the teacher as usual coming to their assistance only where they fail.

1. **Shape of Body.**—The body is **long, thick, and round,** and the head is joined to it with a very **short, thick, strong neck.** The head itself is long, and **ends**

in a strong, pointed snout. All four legs are very short.

Which could you force into the soil best, a round stick pointed like a tip-cat, or a square, blunt one? The **round, pointed one.**

The mole's head and body you see are shaped something like this round, pointed stick. Can you tell me why? It is the best shape **for pushing its way through the soil.**

What is the object of that short, thick, strong neck?

Why are the legs so short?

Lead the children to see the use of the **short, powerful neck** *in tunnelling through the earth, and show also that* **short legs are not in the way** *as long ones would be.*

2. **The Fore-paws.**—*Call attention to the* **broad, flat, shovel-like paws,** *with their* **long, strong claws.** They are **splendid digging tools.**

Notice too that they are turned outwards, so that they can **throw back the soil as they dig.** *Compare them with the hind-legs and paws.* **The front-paws do all the digging;** the hind-paws are used for throwing the earth behind as the digging goes on.

3. **The fur Coat.**—*Let the children feel the soft fur.*

The mole is really a handsome little animal, with his **black, glossy, fur coat,** as smooth and even as **velvet.** It seems **too beautiful a coat** for the damp, dirty soil.

Do you think he has much trouble to keep it clean? No, he has not, **for it never gets dirty.** Whenever the mole comes up from his tunnel, his coat is always sure to be **clean, smooth, and glossy.**

Let us see why this is; for we should get dirty enough if we had to crawl through the earth.

Show and explain that the short hairs of the mole's fur **grow perpendicularly up** *from the skin, and compare this with the fur of the cat, in which* **the hairs lie close to the body.**

Notice too that in the cat's fur the little hairs are coarse near the roots and finer at the ends. Tell that in the fur of the mole it is just the opposite. The hairs are **fine at the root** *and* **coarse at the ends.**

Rub the cat's fur the wrong way and it ruffles up; but it does not matter which way the mole's fur is rubbed.

It **bends easily either way,** and not only **never ruffles,** but **will not allow any of the soil to stick to it.** It all shakes off, as he moves to and fro in his underground home. The mole, therefore, although he lives in such a home, is never dirty.

Notice how thick and close the fur is. It makes a **snug, cosy coat** to keep him warm, as he lies in the cold, damp earth.

4. **The Eyes.**—*Elicit from the class that as the mole lives in the dark earth, where no ray of sunlight ever penetrates, he has* **little need for eyes.**

But think what would happen, while he bored his way in the earth with snout and paws, if his eyes were like those of other animals.

Little particles of earth would get into them, and cause him pain and injury.

Tell that the mole's eyes are **very deeply set,** *and* **completely hidden in the thick fur.** *People used to think the animal had no eyes at all, but if a newly caught mole be dipped in water, the eyes can be easily seen. They look like* **two little black beads.**

5. **Smell and Hearing.**—*Picture the mole in those dark underground tunnels. He must have some means of finding his way as he prowls about in search of his prey.*

Tell that his **sense of smell is very keen,** *and his* **hearing also very sharp.** *These guide him in place of eyes.*

A strange thing about the mole is that there are **no outer ears to be seen** like those of other animals.

Let the children examine the mole and see that it is so. Tell or elicit why.

In connection with the mole's sense of hearing, explain how easily sound travels through the earth. Tell that it is easy to hear the rumbling of the wheels of a cart at a very great distance, by putting the ear to the ground.

The noise made by little animals forcing their way through the earth **is quickly conveyed to the mole,** and away he hurries after them.

Picture a worm in the ground. How rapidly it draws itself back on the approach of danger. **The mole must be very swift** *and rapid in his movements to catch his prey.*

6. **The Teeth.**—*Examine the mouth next.*

The mole's teeth are **long, sharp,** and **pointed**—made specially **for seizing** and **tearing flesh,** not for chewing. He is a greedy, ravenous little animal, and cannot go long without food.

When he cannot find enough food in the way of **earth-worms** and **grubs** in the ground, he sometimes makes his way above-ground, and **catches and kills frogs, field-mice,** and **snakes.** The moment he has killed his victim he tears open its belly, thrusts his snout into it, and begins his meal by gorging himself with its blood.

The farmer lays traps to destroy the poor moles, but although they do some damage to the crops by their tunnelling, they certainly do a great deal of good **by de-**

vouring grubs and beetles, which would otherwise kill the growing plants. After all, he is one of the farmer's friends.

III. The Home Underground

Show a picture of the mole's fortress, and the galleries and

passages leading to it, and endeavour to fill the children with admiration for the clever little miners and their work.

Notice that the "**fortress**" *is always built on one plan. There is* **a circular gallery near the top of the mound,** *and* **another much larger below,** *and the two are always connected by means of* **five short passages.** *The* **middle chamber** *is hollowed out, and a quantity of* **dried leaves** *is piled up in it to form* **a warm, snug nest,** *where the mole*

and his mate sleep, and where the young moles, **four** *or* **five in a litter,** *are reared.*

Notice the underground passages or **runs** *leading to and from the fortress in all directions. These are* **always made wide enough to allow two moles to pass** *each other. If any danger approaches from one quarter they can make off in another, and so seek safety.*

Tell that the mole-hills we see in the fields are simply heaps of earth which the little animals throw up during their mining operations.

Summary of the Lesson

1. The mole burrows in the ground, because it feeds on worms, grubs, and other creatures that live in the ground.

2. Its head, eyes, body, paws, and fur are all meant to fit it for its burrowing life.

3. The front paws are its digging tools. It throws up the earth with its hind-feet as the digging goes on.

4. Its teeth are made for seizing and tearing flesh.

5. The mole's home underground is a circular gallery with passages leading to it from all directions.

LAND AND WATER

Lesson I

THE SEA

The teacher should be provided with the modelling tray and the No. 1 model of the coast. Some water, a tumbler of strong brine, and a large basin will also be required.

I. The Edge of the Land

1. *Commence with a few words about rivers, for the purpose of eliciting what a river is, where it comes from, and more especially what becomes of it at last.*

Rivers **flow into the sea.** In whatever direction a river may run, it must at last reach **the end of the land.** There is no more land for it to flow through, and it then **pours its water out into the sea.**

2. *Imagine four men setting out from the school to walk as far as they could go in four different directions—north, south, east, and west.*

On their way all four might have to **climb high hills,**

N.B.—Full and explicit instructions for building up the models in this and all the subsequent lessons will accompany each modelling tray which is sent out. Every model is so made that it can be fitted up in two or three minutes.

dip down into **low valleys,** and perhaps walk for many miles across **flat, level plains.**

But each of them would find himself at last on **the very edge of the land.**

He would be unable to walk any farther in the same direction, because he would have before him **nothing but water** — not the water of a running stream, like the rivers over which he easily crossed during his walk by means of bridges, but a great sheet of water stretching as far as his eyes could reach.

3. This **great sheet of water is the sea,** and in whatever direction we walk, if we walk far enough, **we must come to the sea at last.**

The edge of the land, which touches the sea, is called by different names—the **coast,** the **shore,** the **beach,** and the **sea-side.**

4. *Show the model, and let the children point out on it the sea and the coast-line near it. Observe that the coast is not everywhere alike. In one place it is* **high and rocky;** *in another it is* **a low sandy shore,** *which stretches away to the very edge of the water.*

We call the high rocky parts the **cliffs;** the low shore the **sands;** but it is all part of the **coast** or **coast-line—the land nearest the sea.**

5. *Ask the children to imagine themselves (with the help of the model) to be standing on the edge of one of these tall cliffs, and looking out to sea. Picture the* **curve of the sky** *bending down in the far distance, till* **sky and water seem to meet.**

What name shall we give to that line, where the sky seems to touch the water? **The horizon.**

II. The Tide

1. *The thing which usually impresses a child most when he pays his first visit to the sea, is the constant washing of the waves on the shore. Deal with this now in some such way as follows :—*

I throw a stick into a pond. What happens? The stick floats on the top of the water, but **does not move.**

Why not? Because the **water of the pond is still** or **standing water. It does not flow.**

2. What would happen to the same stick if I threw it into a river? It would **float away** out of sight.

Why? Because rivers are **flowing streams of water.** The water, as it flows, carries the stick away.

In which direction do rivers flow? They always flow in one direction—**downwards from the source to the sea.**

3. *Now picture to the children the water of the sea.*

It is **never still.** Day and night, summer and winter, all through the year, **the waves are constantly rolling up on the beach.** It is a grand sight to watch the waves roll up, and break on the shore in white foam.

We say that **the sea washes the land.**

4. *Proceed next to elicit step by step, from those who have been to the sea, that at one part of the day,* **people can walk out a long way** *on the sands, but that later on in the same day there is* **nothing but water to be seen there.** *The sea comes in closer to the land, and covers the place where the people were walking about a few hours before.*

This will lead to the natural inference that the water of the sea **does not flow in one direction only,** *like the water of the rivers, but in two directions—*__up and down.__

5. *Explain that for six hours every wave which rolls in comes*

a little farther up the beach *than the one before it, and that in this way the water gradually* **flows up,** *or* **rises,** *higher and higher, till at last it reaches its highest point.*

All this time we say **the tide is flowing,** or **rising,** and when the water has reached its highest point, it is seen to be close up to the land everywhere along the coast. We then say it is **high tide** or **high water.**

Tell that if we watch the waves at high tide, we always notice that although they keep rolling in one after another as before, **the water does not rise any higher.** *It remains at the same level.*

This goes on for about **ten** or **twelve minutes,** and the tide is said to be **turning,** because at the end of that time each wave begins to fall a little short of the last, and so **the water does not come so far up on the shore.**

6. *Explain that for the next* **six hours** *every wave falls a little short in this way, and so the water by degrees gets lower and lower, and more and more of the beach is left dry.*

We then say **the tide is ebbing** or **falling,** and at the end of the six hours **the water reaches its lowest point.**

This is the time when people are able to walk out a long way on the sands. It is **low tide** or **low water.**

7. *Explain that after remaining at low-water mark for about* **ten or twelve minutes,** *the tide* **begins to turn** *once more, and* **for the next six hours** *it* **rises,** *or* **flows in** *towards the land as before.*

This flow and ebb of the tide goes on without ceasing, day after day, year after year, so that **every twelve hours the water rises and falls once.**

8. *Notice that at every turn of the tide there is a loss of a few minutes, and that in consequence of this,* **each tide is always a little later** *than the last, as the water takes fully* **six hours to flow,** *and* **six hours to ebb.**

But allowing for this we can tell the exact minute, day

by day, when it will be high tide or low tide, and we can even tell how high the water will rise.

III. The Rivers Feed the Sea

1. I stand a saucer of water out in the sun. What happens? The water passes away in **vapour**, and leaves the saucer dry.

Think then of the wide-stretching sea, where there is nothing but water to be seen on every side, as far as the eye can reach.

What must be always going on there? The sea must be always **losing some of its water in vapour.**

What becomes of this vapour? It rises in the air and **forms clouds.**

2. *Point out that the sea provides by far the greater part of the moisture which forms the clouds—that there could be no clouds to speak of without the sea.*

Then, as the sea is constantly losing its water in this way, how is it that it does not dry up, as the saucer of water would?

Lead the children, step by step, to tell the reason. The **clouds fall in rain,** *the* **rain makes rivers,** *the* **rivers flow** *through the land, and* **pour out their water** *at last* **into the sea again.**

The **rivers feed the sea.** There is as much water poured into the sea day by day from the rivers as is taken out of it in the form of vapour. **Hence the sea can never dry up, nor can it ever be too full.**

IV. Sea-Water always Salt

1. *Refer to the lesson on Salt, and remind the children that in it we spoke of the saltness of the sea.*

Sea-water is always salt, nearly as salt as brine. We could not drink it. The water of **springs** and **rivers**

is not salt. It is **fresh water.** This is the water which provides us with drink; it has no taste whatever.

Elicit, from what has already been taught, the reason for the saltness of sea-water.

Deep down in the crust of the earth there are **great beds of rock-salt,** and the water, as it trickles through the earth on its way to the sea, **dissolves some of this salt,** and carries it away in solution. It is **this dissolved salt that makes the sea-water salt.**

2. *Produce the tumbler of strong brine, and let the children taste it. Pour this brine into a large basin, and proceed to dilute it with tumblers of fresh water, letting the children taste it after each addition, and explain what they observe.*

The water gets less and less salt every time, till at last we can barely taste any saltness in it.

Now remind them that, as the sea is day by day being filled up with fresh water from all the rivers, we should naturally expect that this would in time make the water of the sea less and less salt.

We know it is not so—that in spite of all this fresh water pouring into it, **the sea is as salt as ever it was.** How is this?

3. *Refer to the lesson about "things that dissolve," and lead the children to tell the reason why we were able to get the dissolved salt and sugar back by boiling the solutions.*

The **vapour** that rises from water **never takes anything away with it.** Whatever may be mixed with the water—whatever may be dissolved in it—whether sugar, salt, or anything else—it is all **left behind;** nothing but water-vapour can pass away.

4. *Show from this:—*

(*a*) That although such vast quantities of water-vapour pass away from the sea to form clouds, **all the salt is left behind.** Not a particle of it rises in the vapour.

(*b*) That all this salt left behind from day to day does

not make the sea salter and salter, because **just as much fresh water is poured into it** by the rivers as is taken out of it **in the form of vapour** to make clouds.

In connection with all this ask the children to catch some rain-water as it falls from the clouds, and taste it for themselves. It does not contain a particle of salt although it came from the salt sea. **It is fresh water.**

Summary of the Lesson

1. **The coast** is the land nearest the sea.
2. The high, rocky parts of the coast are called **cliffs**.
3. **The tide of the sea** ebbs and flows twice every twenty-four hours.
4. The rivers feed the sea; the sea feeds the clouds.
5. The sea-water is always salt, because the vapour does not take away from it any of the salt, when it rises to form clouds.
6. The rain which comes from the clouds is fresh water.

Lesson II

THE SEA AND THE LAND

The following articles will be required for illustration: the modelling tray, and No. 1 model of the coast, with some clay, sand, chalk, and pebble-stones; a garden watering-pot; two or three pieces of sandstone; a hand lens; a round boulder stone; some pebbles and shingle. A freezing-mixture should be prepared with equal quantities of pounded ice and salt, and before the lesson commences a well-corked soda-water bottle filled with water should be immersed in it.

I. Introduction

1. *Commence by introducing the model, and make it the connecting link between the new lesson and what has already been taught.*

What name do we give to the land nearest the sea? The **coast,** or **coast-line.** Let us trace this coast-line in the model.

What sort of line would you call it? A very **crooked** and **broken line.** It runs first in one direction and then in another.

Notice that in one place **the land stretches out** *a long way* **into the water,** *while in another* **the water runs up into the land.** *It looks as if a great bite had been taken out of the land, just as we take a bite out of a slice of bread, and that the sea had flowed in to fill up the gap.*

2. *Notice next that one part of the coast is* **high,** *another part* **low,** *and elicit that the higher parts are called* **cliffs.**

Tell that some cliffs rise many hundreds of feet above the sea, and they are always very **steep** *and* **rugged;** *that some are made of* **hard, stony rocks,** *others of* **chalk.** *Show both in the model.*

3. *Lastly, call attention to the* **low-lying shore,** *which stretches down to the edge of the water. Point out that this consists mostly of* **sand and shingle,** *and then notice that near the base of the cliffs the shore is* **strewn with huge rough masses of rock,** *which look as if they have been broken off from the cliff itself.*

The land nearest the sea **wears away little by little,** and it is this which breaks the evenness of the coast-line. Let us find out how it all happens.

II. Some Experiments

1. *Pile up some clay, sand, chalk, and stones (large and small), in a compact heap on a slightly tilted board or tray, and let one of the children pour water on the heap from the watering-pot, calling upon the class at the same time to observe and tell what takes place.*

(*a*) The water **washes away the sand** in a very short

time, and leaves hollows between the clay, chalk, and stones.

(*b*) It washes **little particles of the clay and chalk away** too, as may be easily seen from the colour of the water which flows from the tray; but **it takes away so little** that it would be a very long time before it could wash all the clay, or all the chalk away, as it did the sand.

(*c*) The water **seems to have no effect at all on the stones;** they all remain just as they were at first.

2. *Remove the soda-water bottle from the freezing mixture now, and point out that it has* **burst.** *Remind the children of the* **bursting of water-pipes in frosty weather,** *and explain (of course in the simplest way possible) that* **when water freezes,** *and becomes solid ice,* **it swells out,** *and wants more room.*

Show that the water in the bottle has been frozen into ice. The solid ice may be seen oozing through the split in the bottle. The bottle burst **because it could not stretch to make more room for the ice** *as it froze.*

Tell that if water becomes **lodged in the cracks and crevices** *of the hardest stone,* **the next frost will cause the stone to split** *as easily as the bottle was split by the freezing water in the basin.*

3. *Take two pieces of sandstone, and rub them together over a sheet of white paper, calling upon the class as usual to note what happens.*

Little rough particles, or **grains,** fall from the stones as they are rubbed.

Have these grains examined with the help of a magnifying lens, and compare them with the **grains of sand** *in the saucer. Both are alike in every particular.*

These little rough grains, which we made by rubbing the stones one against the other, are **actually grains of sand.** This sand in the saucer **was once solid stone** or **rock,** like the pieces we have been rubbing.

All the sand on the sea-shore has been **made from the solid rock** or **stone,** which forms the cliffs.

III. A Storm at Sea

1. *Refer once more to the river, and lead the children to describe the calm, quiet way in which it flows on, day after day, with scarcely a ruffle on its surface.*

Contrast this with the sea, which is **always changing.** *At one time its surface is almost as smooth and unruffled as the surface of the river. Then a wind springs up, and* **the water is blown along in waves,** *and the stronger the wind the bigger the waves.*

Show the children how they can **make little waves for themselves** *by blowing on the surface of some water in a tub.*

2. *Tell that sometimes the wind is so strong, and the waves are driven along with such force, that the sea itself, instead of being smooth,* **looks like great hills of water with deep valleys between them.**

A brisk wind is called **a gale; a very strong wind** is **a storm.**

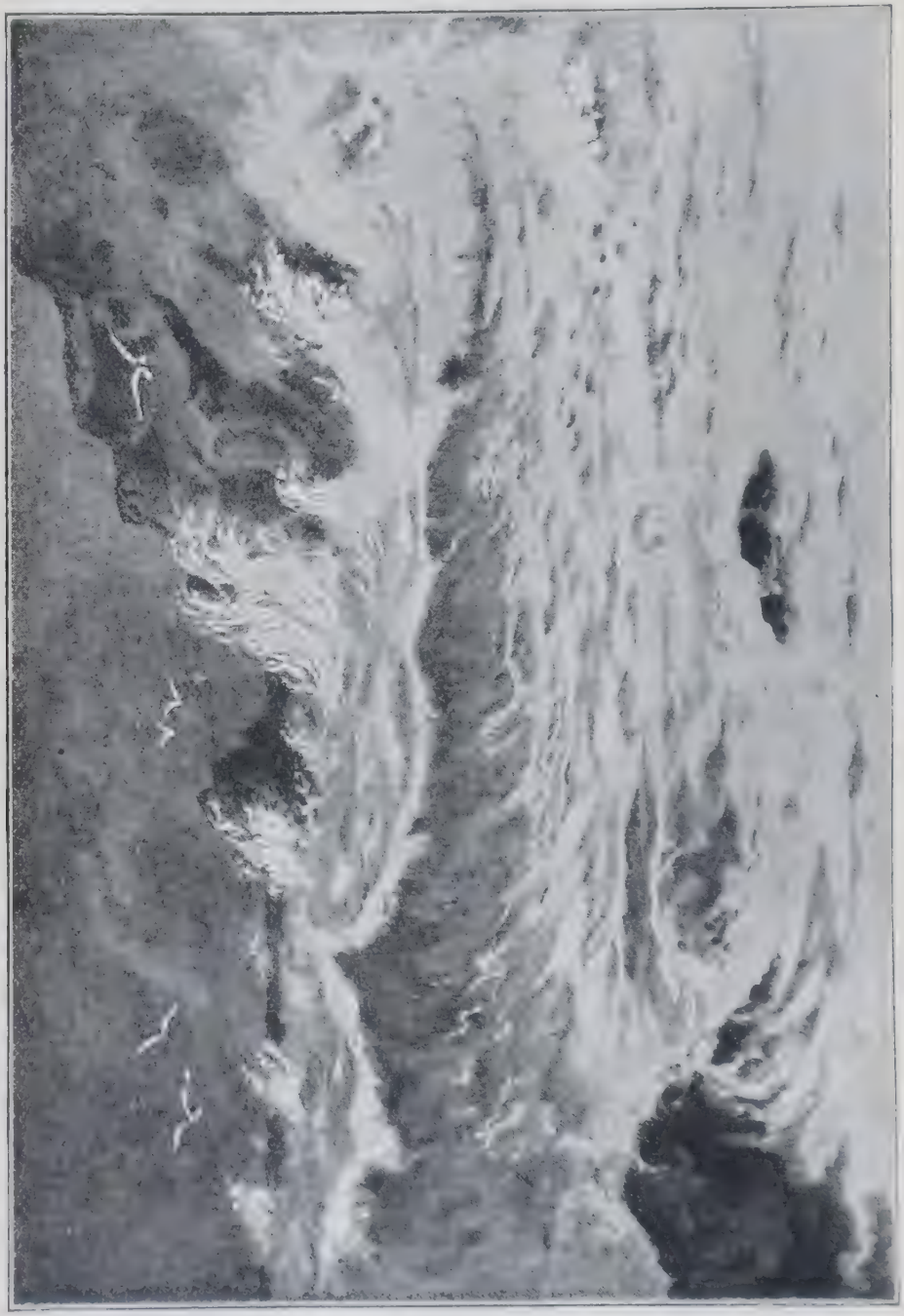
Show a picture of a storm at sea, with **the great waves** *leaping up and* **dashing over the rocky shore,** *and call special attention to the force with which the raging mass of water beats upon the land.*

N.B.—*The teacher should remember that it is no part of our present plan to deal with the storm in its relation to ships and sailors. That will come in its place later on. Our present object is simply to account for the varying nature of the coast-line, and it is best to deal with one thing at a time.*

IV. The Destructive Force of Water

1. *It will be an easy matter now to lead the children themselves to tell the rest of the story.*

Remind them to begin with of the experiment with the watering-pot, and elicit that although the water seemed to have no effect



A STORMY SEA.

on the hard stones, it washed away more or less of the other materials—**the sand in large quantities,** *and* **some of the chalk and clay.**

Compare this with the waves beating on the sea-shore, and elicit that they too **wash away the sand and soft earth in immense quantities,** *while they seem to have very little effect on the hard rocks.*

2. *Explain that those great bites in the coast-line have all been made by the sea; and that the land there was once formed of materials which* **the sea could easily wash away.**

It washed them away, and as it did so it rushed in, to fill up the gap which was made.

3. *Point next to the* **long tongues of land which stretch out into the sea,** *and lead the children to infer that the reason why these are not also washed away by the waves, is that* **they consist of hard rock** *and not loose, soft material.*

4. *Picture the waves beating against the base of a chalk cliff.*

Their work is slow but sure. They **wash away the chalk, little by little,** often making **great holes in the cliff,** which we call **caves.** Sooner or later they end by undermining the cliff, and then all of a sudden **a great mass of it falls.** (*Show the caves in the model.*)

5. *Pass on next to consider the action of the* **winter frosts on the harder rocks.** *Lead the children to tell what they know, and then explain that this is always the cause of much damage on a rocky coast.*

Every spring fresh masses of rock may be seen strewing the shore, to tell of the **work which the winter's frosts have been doing.**

6. *Lastly, call attention to the* **sand** *and* **shingle** *of which the low-lying shore itself is composed. Point out that* **the**

great pieces of rock *which fall from the cliff are* **roughly broken,** *with* **uneven surfaces** *and* **sharp, jagged edges.**

Then show, if possible, a **boulder,** *a* **few large pebbles,** *some* **shingle,** *and lastly some of the* **sea-sand.**

These have no sharp, rough, jagged edges; they are all **smooth** and **rounded**; their rough edges have all been worn down. Yet they all came from the rough pieces which fell from the rocks above.

7. What can have made the change?

Tell that **the waves have done it all.** *As they beat upon the shore, they dash these stones about, like feathers in the wind, and every time one stone rubs against another,* **its rough edges are chipped and rubbed off,** *till in time it becomes* **smooth and round like these pebbles.**

Nor does it end here, for the same ceaseless action of the waves chips, breaks, and wears down these pebbles themselves, and reduces them to **fine grains of sand,** *just as we did by rubbing the two stones together.*

Summary of the Lesson

1. The coast is uneven because the sea wears it away little by little.

2. It wears away the softer parts of the land more easily than the hard rocks.

3. Wherever the sea wears away the coast, it flows in to fill up the gap; but the hard, rocky parts of the coast stretch out into the sea, because they are not worn away.

4. The winter frosts split and break the hard rocks.

5. The broken pieces of rock are dashed about by the waves. They rub against one another till they become smooth, round pebbles.

6. Sand is made from pieces which have been broken off from these rocks, and ground up into fine grains by the waves.

Lesson III

THE COAST

Provide for illustration: the modelling tray, with No. 1 model; some sand, shingle, and pebbles, and the toy ships.

I. Introduction

1. *Produce the model, and at once begin, by means of a few well-chosen questions, to refresh the children's memory on the subject of the preceding lesson, the purpose being to impress upon the class once more that* **the uneven coast-line,** *the* **rock-strewn shore,**—*even* **the sand, shingle,** *and* **pebbles** *that make the shore itself,*—**all are the work of the waves.**

2. *This done, point out that, when we speak or read about different things of any sort, we are able to tell one thing from another without seeing either a picture or a model, because each one has its own name, and the name calls up in our mind a picture of the thing itself. Give one or two examples of common things.*

Tell that, in like manner, names have been given to all the different parts of the coast, in order that whenever we hear the name of any one of them, we may at once form a picture of it in our mind, and so understand what is meant.

We will now learn the names that are given to these different parts of the coast.

II. The Land that Touches the Sea

1. **The Shore.**—Let us commence with the low-lying part of the land, which stretches down to the water's edge.

This is known by various names — the **shore,** the **beach,** the **strand,** the **sands,** and so on.

If we turn to our model we see that in one place the shore consists of **fine sand** from the foot of the cliff to the water, while in another there is no sand at all—nothing but **shingle or pebbles.**

Show a handful of shingle, and point out that they are always smooth, rounded stones, **made so by the wash of the waves.**

Tell that in some places on the actual sea-shore the shingle consists of small stones like these, but in others the shore is made up of great rounded pebble stones, **bigger than a man's head.** *These are called* **boulders.**

A **pebbly shore** of any sort is properly called **a beach,** but people do not always confine the name beach to this kind of shore.

What name do we give to this high, rocky part of the coast? The **cliff.**

Look, here is a great hole in the foot or base of the cliff. What do we call that? A **cave.**

2. **Heads or Headlands.**—Now if you run your eye along the cliff in the model, you will see that part of it **stretches out into the water** a long way beyond the rest, and our model will help us to form a very good idea of what the actual coast looks like.

Place one of the little ships on the imaginary water, and move it slowly towards the shore.

This rocky piece of the coast **stretches out so far** into the sea, and **stands up so bold and high** against the sky, that it must always be **the first land the sailors see** as their ship sails in.

At the first sight of this land, the sailors might almost fancy it to be **some huge beast** rising up from the water, and **rearing its head out towards the sea.**

Tell that there is no doubt some of our sailors in the old old times did actually fancy things of this sort, for wherever they met with **high land stretching out into the sea** *like this,* **they always called it a head,** *and we ourselves still call it by the same name.*

3. **Capes are Heads.**—*Notice that, strangely enough, our early English sailors were not the only people to fancy things of this sort. Sailors of foreign countries also thought that land stretching out into the sea* **looked like a great head,** *and they too* **called it a head,** *although their word for* **head** *is not the same as ours.*

Cape is their word for **head,** and this is the name they gave to it, but remember it means **exactly the same as our word head.**

Cape, head (or **headland** as we sometimes say) are all names given to land which **stretches out into the sea.**

Show a boy's cap. Ask for its name and its use. It is called **a cap;** *it is a covering* **for the head.**

Remind them that there is another article of clothing, with a name almost exactly like this—**a cape.**

Tell that when capes were first worn they always consisted of two parts—**a large hood to cover the head,** *and another part to hang over the shoulders. They were called capes,* **because the part which covered the head** *was thought the most important.*

This homely illustration will help to fix the idea in the children's minds that **cape and head mean the same thing.**

III. The Sea that Touches the Land

We have talked about the land that stretches out into the sea; let us now turn our attention to the parts of the sea that run into the land.

Call one of the children to the front, and ask him to point out examples of these in the model.

1. **Bay.**—Suppose we begin with this large one, which (as we once said) reminds us of **a bite taken out of a slice of bread.** Look at it carefully, and see what you can find to tell me about it.

In this way lead the children themselves to observe and tell:—

(*a*) That it **does not run very far into the land;**

(*b*) That it is **wider at the entrance** than in any other part; and

(*c*) That the **shore bends in** towards the land with **a rounded sweep or curve.**

Tell that a part of the sea, **which runs a little way into the land** *as this does, and is* **wider at the entrance** *than anywhere else, is called* **a bay.**

Illustrate this by referring to the bay-window of a room. The bay portion of the floor does not extend very far beyond the rest, and it is always wider at the entrance than at any other part.

2. **Gulf.**—Here is another place where the sea runs into the land. I want you to look at this one, and compare it with the bay, to see what difference you can find in the two.

The children will have no difficulty in pointing out—

(*a*) That this one **runs a long way into the land;** and

(*b*) That it has **a narrow entrance.**

Tell that **a narrow inlet** *of the sea, which* **runs a long way into the land,** *as this one does, is called* **a gulf.**

3. **A Harbour.**—Now I want you to look carefully at this little inlet.

Which is it most like—a bay or a gulf? A gulf.

Why? Because it has **a narrow entrance.**

Point out that it not only has a narrow entrance, like the gulf, but it is narrower at the entrance than in any other part. It spreads out into a wide sheet of water after it enters the land.

Tell that this is a little gulf too, but because of its narrow entrance it is **very useful to the ships.** We call it **a harbour,** or **a haven.**

Lead the children to think of a storm at sea. Tell that when the storm is raging, the waves are driven along with such force by the fury of the wind, that **big ships are almost helpless**—*they are dashed about as if they were straws on the water.*

Think what would happen if the ship were dashed against the rocky shore. The rocks would break it in pieces; **it would become a wreck,** and all the poor sailors would be drowned.

Whenever they see a storm coming up, the sailors always try, if they can, **to run their ship into a harbour,** and then they are safe, because the raging waves cannot force their way through that narrow entrance. They are **broken up and spent,** as they dash themselves against the rocks, before they enter the harbour, and the **ship can ride there in perfect safety** till the storm is over.

We say the rocks at the entrance to the harbour make a natural **breakwater,** because they **break up the waves** in this manner.

Breakwaters are sometimes **built at the mouths of harbours** to still further protect them. These breakwaters are immensely **strong sea-walls,** built of the hardest of stone.

Point to the breakwater in the model.

IV. A Map of the Coast

1. Our model, you see, has given us a very good idea of what the different parts of a coast-line look like. It is very important that the sailors on the sea should know the coast-line well, but they cannot carry a model or even a picture of it with them.

What else could they have to tell them all they want to know? **A map.**

2. What could they learn about the coast-line from a map? They could learn **its shape, its length,** and **the direction in which it runs.**

How would they learn its length? By means of **the scale.** So many inches on the map would mean so many miles.

How would they learn anything about direction? **The four cardinal points** are always put on the map. They tell direction.

3. Very good. Now to-day I don't wish to trouble you with either the length or the direction of our piece of coast-line. I will simply let you see **how we show the shape of it in a map.**

Draw an outline of the coast in chalk on the board, side by side with the model, and let the children tell where the names **cape, head, bay, gulf, harbour** *are to be written.*

Summary of the Lesson

1. **Shore, beach, strand,** are all names for the sandy or pebbly coast which is washed by the sea.

2. **Caves** are holes worn in the cliffs by the washing of the sea.

3. **A Head** or **headland** is a bold, rocky piece of the coast, which stretches out into the sea.

4. **Cape** is another name for head, or headland.

5. **A Bay** is a part of the sea which runs a little way into the land, and is wider at the entrance than anywhere else.

6. **A Gulf** is a part of the sea which runs a long way into the land, and has a narrow opening.

7. **A Harbour or Haven** is a small opening, where ships may ride in safety during stormy weather. It has a **breakwater** to protect it from the sea.

N.B.—*The time of the next lesson should be devoted to a recapitulation of what has been taught, for the purpose of committing the above to memory, and the children themselves should be called upon (under the teacher's direction of course) to make models in clay or sand of capes, bays, gulfs, etc., and also to draw plans or maps of them afterwards.*

Lesson IV

THE COAST (SECOND LESSON)

The teacher will require the modelling tray and model No. 2, the toy ships, some clay, sand, and water.

I. Island

1. *Uncover the model, and commence by calling upon the children to point out in it the now familiar features of the coast-line—capes, bays, gulfs, and so on.*

That done, ask whether they can see anything in this model which they did not see in the last. Lead them to notice one of the pieces of land standing up in the midst of the water.

This land is quite **separate from all the rest.** It is cut off from the rest of the land by the water.

2. Think of a large piece of land like this **in the middle of the sea.** If we were living on it, whichever way we walked **we must always come to the sea.**

How could we get to the larger land on the other side? We should have to go in a ship.

Let one of the children take the little ship across, and back again.

Ask him now to act as captain, and take his ship for a voyage along the coast. Observe that at the end of the voyage **he brings his ship back to the very place from which it started.**

3. This piece of land **has water all round it.** We say it is **surrounded by water,** and we call it **an island. An island is land surrounded by water.**

Write the word **is-land** *on the board, with its meaning.*

Tell that the word island means **water-land—land in the midst of the water.** *Call upon the children to point out other islands in the model.*

4. *Notice that some of these islands are much smaller than the others. We call them* **isles.**

An isle is a small island, and **a very small island** is sometimes called **an islet.**

People who live on an island know that their land is only **a part of the larger land on the other side of the water,** and they always speak of that larger land as **the mainland,** that is to say, the principal part of the land.

II. Peninsula

1. Let us leave the islands now, and go across in our ship to the mainland.

Can you see any part of the mainland that looks almost like an island?

Call upon one of the children to point it out.

Why do you say this is almost an island? Because it has **water nearly all round it, but not quite.** There is one part where it is **joined to the mainland.**

2. What joins it to the mainland? **A narrow strip of land.**

Ask the child to point out this narrow strip of land, and let him show that the ship could sail all round till it came to this part, but it would stop there, **because the water is not all round the land.**

Tell that when a piece of land is **almost an island,** *we call it* **a peninsula.**

The words **pene-insula** *mean* **almost an island.** *Write the word on the board, with its meaning.*

3. Now look again at the model, and see whether you can find any more peninsulas—any more land **with water nearly all round it,** but not quite.

Lead the children to pick out the other examples, and to give their reasons for calling them peninsulas—**they have water on all sides but one.**[1]

4. What difference do you notice between these peninsulas and the one we found first? The first one is joined to the mainland by a narrow strip of land; in the others **the whole of one side of the peninsula is joined to the mainland.** There is no narrow strip of land between.

5. Suppose we now look at the first peninsula once more. The narrow strip of land which joins it to the mainland reminds us of **the neck which joins our head to our body,** and that is why people have called it **an isthmus.**

This is an ugly foreign word, but it only means **a neck** after all. I will write it on the board, for I want you to remember it, ugly as it is.

Write it slowly—**isth-mus**—*and let the children spell it several times. Then rub it out, and call upon two or three of the children to come to the front and write it again, while the rest dictate the spelling.*

6. Now I wonder whether any of you are clever enough

[1] The capes and headlands are in reality little peninsulas, for they too have water on all sides but one.

to tell me how a peninsula like this could be made into an island. Watch and I will show you how it can be done.

Pour some water rather roughly against one side of the isthmus, which has been prepared for the purpose with sand, so as to wash it away, and **separate the two pieces of land.**

Call upon the children to observe that the piece of land that was a peninsula **is now an island.**

It is quite separate from the mainland; **it has water all round it;** we can sail our ship all round it, and come back to the same place again.

7. A little while ago we spoke of the islands as being part of the mainland.

Can you tell me now how they came to be separated? **The sea must have washed away the land between them.**

Tell that this is exactly what has taken place at some time or other. The sea has washed away some of the land, and made **a narrow passage of water** *where the isthmus once was, and so land which was once a peninsula* **has been changed into an island.**

III. Strait

1. *It will now be a perfectly natural step to turn to the model once more, and call attention to* **the narrow passages of water,** *which separate the islands from the mainland, and one island from another.*

Tell that these narrow parts of the sea have their names as well as the other parts.

A narrow passage of water between two pieces of land is called a strait.

Write the word, with its meaning, on the board, and be particularly careful to impress upon the class that the word has no connection with the word "straight," although both are sounded alike.

Strait means **narrow. Any narrow part of the sea with land on both sides is called a strait.**

2. *Point out, and show with the help of one of the little ships, that a strait is always* **open at both ends,** *so that ships may sail through the narrow passage from one part of the sea to another.*

3. **A channel,** like a strait, **is a passage of water,** which divides two parts of the land, and joins two parts of the sea. **But a channel is wider than a strait.**

Pour a good stream of water through one of the straits, which has been prepared for the purpose with sand, and show that when the sand is washed away, the strait is widened and converted into a channel.

4. *Tell that the sea,* **by washing away some of the land on either side,** *in time makes the strait wider and wider, till* **it becomes a channel.**

Now let us have one more look at our model. I will fill up the strait between this island and the mainland, and I will join the other one to the mainland by a narrow neck of land. *Use sand or clay for this.*

What have I done in both cases? **Both islands have been changed into peninsulas.**

IV. The Map

As in the last lesson, lead the children again to tell the meaning and purpose of a map, and this done, proceed to draw in chalk, on the board, side by side with the model, an outline of the parts described in the lesson, calling upon the children to fill in all the names.

Summary of the Lesson

1. **An island** is land surrounded by water. A small island is called an **isle**. A very small island is an **islet.**

2. The larger land near an island is called the **mainland**.

3. **A peninsula** is land almost surrounded by water.

4. **An isthmus** is a narrow neck of land which joins a peninsula to the mainland.

5. **A strait** is a narrow passage of water between two pieces of land.

6. **A channel** is a wide and deep strait.

N.B.—*The time of the next lesson should be devoted to a recapitulation of what has been taught, for the purpose of committing the above to memory, and the children themselves should be called upon (under the teacher's direction) to make models in clay and sand, representing islands, peninsulas, isthmuses, straits, and channels, and also to draw plans of them on their slates.*

Lesson V

ROCKS AND SANDBANKS

Have in readiness the modelling tray with model No. 3 arranged, and the lower part of the tray modelled in sand and clay to represent the bottom of the sea. The toy ships will also be required.

I. Introduction

1. *Produce the model, and as usual commence with a brief and rapid recapitulation of the subjects which have been already dealt with in the foregoing lessons.*

Call upon the children—

(*a*) *To point out in the model examples of the various features —capes, islands, peninsulas, straits, bays, etc., as asked for by the teacher.*

(*b*) *To describe them one by one in their own way; and*

(*c*) *To give the formal definitions which have by this time been committed to memory.*

2. *Call particular attention to the little inlet of the sea on the model, the narrow entrance to which is protected by a natural wall of rock and a* **breakwater.** *Elicit that this is* **a harbour,** *and that it provides* **a place of safety for ships** *in stormy weather.*

N.B.—*It should be borne in mind that this is a subject in which there can scarcely be too much or too frequent recapitulation.*

Now that you know something about the land and the sea near it, I want to show you next what the bottom of the sea is like. Our model will tell us all we want to know.

II. Islands and Rocks

1. *Draw the upper tray carefully out of the frame without disturbing the arrangement either above or below it. This done, lift the models off the tray itself with the same care, and place them in their proper position on the truncated portions, above the level of the imaginary water. The edges of the paper on which each model now rests will show the water-line.*

Point out that the whole model, as it now appears, shows us **what the bottom of the sea would look like,** *if all the water were drained out of it. Call upon the children to examine it carefully, and see what they can learn about it.*

2. *The first thing to strike them will most likely be that* **the sea-bottom,** *like the surface of the land,* **is made up of plains, hills,** *and* **valleys.** *Let them point these out in the model.*

Call attention to these **sea-hills,** *and notice that the tops of some of them rise up above the surface of the water, so that* **they have water all round them,** *and in this way elicit that what we call* **islands** *are only* **the tops of these hills in the sea** *which show above the water's edge.*

3. *Tell that in some parts of the sea large clusters or* **groups**

of islands *are met with, and all of them are the tops of hills or rocks* **which rise up from the bottom of the sea.**

A **group** or **cluster of islands** in the middle of the sea is called an **archipelago.**

Write the word in syllables on the black-board, and have it spelt in the usual way by the class.

4. *Notice next—*

(*a*) *That the tops of some of the sea-hills* **slope up gently from the sea,** *and are smooth and rounded.* These form **a sloping, sandy sea-shore.**

(*b*) *That the tops of others are* **steep, rugged rocks,** *which rise high out of the water.* These form **cliffs and headlands.**

(*c*) *That in other places again they do not rise high enough out of the water to form cliffs. Some of them* **just peep up through the water;** *others do not reach the surface—*their tops are hidden below the water's edge. These are **rocks, not islands.**

III. Sandbanks and Roads

1. *Call attention in the next place to the long, sloping ridge of sand which rises up from the sea-bottom to the surface of the water.*

It is **a long sea-hill made of sand** which the sea washes up, but it does not show above the surface of the water. We call it **a sandbank.**

Notice that it extends for a long distance almost parallel with the shore, so that there is **a deep valley between the shore and the sandbank itself.**

2. *Remind the children that, if this bank or hill in the sea were made of hard, solid rock, instead of sand, and rose up* **above the surface of the water,** *it would form* **an island;** *and then elicit that the passage of water between an island and the mainland is called* **a strait** *or* **a channel.**

3. *Show that, although it is only made of sand reaching up to the water's edge, there is still* **a passage of water between it and the land.**

The passage or channel of water **between a sandbank and the land** is called **a road,** or **a roadstead.**

Tell that, in stormy weather, when the waves are dashing about on the other side of the sandbank, **the water in the road is almost quiet,** *because the sandbank stands there like a great wall from the bottom of the sea and* **keeps the waves back.**

4. *Lead the children from this to think of the purpose of a harbour.*

In stormy weather ships put into a harbour for safety, **because the storm cannot reach them there.**

Tell that, in the same way, **the roads or roadsteads** *provide* **a place of safety** *for ships, because* **the sandbanks prevent the great waves from rolling in.** *As they dash against the sandbank on the other side they are broken up, and lose their force.*

IV. How Ships are Wrecked

1. *Replace the tray representing the sea now, with the islands and rocks in their original positions, and sprinkle a little sand on it to show the position of the sandbank below.*

Set one of the little ships on the imaginary water, and move it slowly on towards the harbour, **making it pass close by the sandbank and the half-hidden rocks.**

2. *Picture the real ships on the sea. Remind the children of the* **dangers of the terrible rocks.** *If a ship strikes on them, they tear a hole in its sides, the water rushes in, and it is soon* **broken up** *and* **dashed to pieces** *by the waves.*

The ship becomes a wreck and all the poor sailors perish.

Point out that the **sandbanks are as dangerous** *in their way as the rocks, for if a ship is driven on to a sandbank, it gets* **wedged in and held fast by the sand,**

and then **the waves dash over it** *and* **break it in pieces** *in a very short time.*

A shipwreck is a very awful and terrible thing.

3. *Tell that every ship carries its own charts or maps of the sea, and all the dangerous rocks and sandbanks are marked on those maps.*

If the sailors only know what part of the sea they are in, they can always find **from their maps** the exact position of these dangerous places, and then they can keep away from them.

How are they able to find their way on the sea? The sun guides them **in the daytime,** and the stars **at night.**

4. Then in the daylight and on a bright, starry night they are quite safe, because they know where they are going. But think of them **in stormy weather,** and **in the darkness and fog,** when they have **neither sun nor stars to help them.** What is to happen to them then?

Tell that even in the worst of weather, the darkest of nights, or the densest fog, the poor sailors are not left helpless on the sea; that they have **a very wonderful instrument** *called a* **compass,** *which* **shows them the way to go,** *when they have nothing else to guide them.*

Promise the children that they shall learn all about this clever instrument soon.

Tell them too that in the next lesson we intend to show them how we take care of our sailors on the sea, and save them from being wrecked on those terrible rocks and sandbanks.

Summary of the Lesson

1. The bottom of the sea, like the surface of the land, is made up of plains, hills, and valleys.

2. The tops of the sea-hills, which show above the water's edge, form islands and rocks.

3. **An archipelago** is a cluster of islands in the midst of the sea.

4. **A sandbank** is a long sea-hill made of sand, which does not show above the surface of the water.

5. **A road or roadstead** is the passage or channel between a sandbank and the coast.

6. **A roadstead** provides a safe anchoring-place for ships during stormy weather.

7. A sandbank is as dangerous for ships as the rocks.

N.B.—*The time of the next lesson should be devoted to recapitulation as before, and the children should be called upon to make models in clay and sand, representing the sea-bottom, the coast, islands, rocks, and sandbanks.*

Lesson VI

DANGERS OF THE SEA

The teacher will require the modelling tray with the model arranged as in the last lesson, except that the lighthouses and light-ship will be fixed in their proper positions, so that they can be lighted up with the electric light the moment they are required. The toy ship and the model of the life-boat should also be in readiness, and a large inflated bladder and a bowl of water will be required.

I. Introduction

1. *Uncover the model, taking care to keep the wires and the rest of the arrangements out of sight. The children will of course immediately recognise this as the model of their last lesson.*

Let them point out the various features represented in it—the **islands**, *the* **sandbank**, *the* **rocks**, *the* **little harbour** *with its sheltered entrance, and so on.*

What do we call this part of the sea between the sandbank and the land? Why is it useful? How is it that ships can ride in safety there, even in stormy weather? Why is the sandbank itself dangerous for ships?

2. *Call upon the children now to look closely at the model, and see whether they can find anything in it which they did not notice when they saw it last; and in this way direct their attention to—*

(*a*) *The* **two tall towers**—*one at the mouth of the harbour, and the other on the rocks out at sea.*

(*b*) *The* **strange-looking ship** *floating above the sand-bank, with a sort of round cage at the top of its mast.*

Tell that the two towers are **lighthouses**; *that strange-looking ship is a* **light-ship**. *We are going to learn something about both now.*

II. The Lighthouse

1. *Lead the children to think of* **the street-lamps of a town,** *and proceed to elicit step by step—*

(*a*) That they are fixed on **tall lamp-posts** along the streets and roads, in order that they may shed their light in all directions.

(*b*) That when they are lighted after dark, **people are able to go about** as easily as they can in the broad daylight.

(*c*) That without these street-lamps we should not only **lose our way at night,** but we should always be **in danger of doing ourselves some injury in the dark**. We should be **afraid to move very far after dark,** if there were no lamps to light up the streets.

2. *Now picture the sailors on the sea. Their dangers are vastly greater than ours.*

Lead the children to tell that, on every coast there are not only **rocky headlands** *stretching out into the sea, but* **treacherous rocks and sandbanks** *in the sea itself, hidden perhaps beneath the waves.*

The lighthouses are the lamp-posts of the sea. They do for the sailor what our street-lamps do for us. They make it as easy for him **to sail his ship in the darkness of night** as it is in the daylight.

3. *Point to the lighthouse on the half-sunken rocks in the model.*

This one **warns the sailor of danger**. He sees it; he knows there are dangerous rocks there; **he steers his ship away from them**; and he is safe.

Lead the children to imagine what would happen if there were no lighthouse on dangerous rocks like these.

The ship as she sailed along would strike with a terrific crash on those awful rocks, and be dashed and broken to pieces.

4. *Now call attention to the other lighthouse at the entrance to the harbour.*

Point out that this, like the other, warns the sailors of the dangerous rocks; but at the same time **it shows the way to a place of safety** *inside the harbour.*

Now let us look at the lighthouse itself. It has to stand against the fury of the wind and waves in all weathers. It must be **very, very strong**.

5. *Notice that the tower is* **broad at the bottom,** *and narrower towards the top—that it is in shape* **like the trunk of some immense tree** *with its branches lopped off. Explain that, for strength to stand against the storm, this is found to be the best of all shapes.*

Tell too that lighthouses, and especially those on dangerous rocks out at sea, are built of the **very strongest and most durable kind of stone,** *and the foundations are always cut deep in the solid rock itself.*

6. *Call attention to the arrangement at the top of the tower. Tell that in a real lighthouse this is a large room, with* **thick glass all round it** *instead of a stone wall, like the rest of the building.*

It is called **the lantern,** and in it are **powerful lamps,** whose light can be seen for many miles. The lights from some lighthouses can be seen **at a distance of thirty miles across the sea.**

7. *Point out that as these lighthouses are placed all round the dangerous coasts, it is important that the sailors in the darkness should be able* **to tell one from another,** *or they would not know where they were. It is for this reason that* **the lights are not all alike.**

In one lighthouse **the lantern is fixed,** and it shows a bright light which **shines steadily all through the night,** like some very large brilliant star.

In another **the lantern moves slowly and regularly round,** and as it is made partly of glass and partly of wood, the light **first shows itself as a flash** through the glass, is next **hidden by the wooden shutter,** then **flashes out again,** and so on all night long.

8. *This talk about the lights will naturally rouse the curiosity of the children as to how they are lighted and kept burning night after night.*

Point out that there are **no lamp-lighters,** *such as we have in the town, to go round and light these lamps as evening comes on. Tell that men (generally two) are placed in charge of each lighthouse; that* **they live in the lighthouse;** *and that their duty is to* **light the lamps** *in the evening; to* **attend to them** *so that they burn well all night; and the next day* **to trim and clean them,** *in readiness for the coming night.*

9. *Tell that inside those solid stone walls of the tower there are rooms, one above the other, with steps leading up from them to the lantern at the top.* **These rooms are the home of the lighthouse-keepers.**

Picture the life of these brave men, shut up for weeks together in that lonely tower, with the winds howling round them, and the waves in stormy weather dashing up as high as the lantern itself.

Yet they are contented and happy, for they are doing good work. They are saving the lives of hundreds of poor sailors, who would be lost without their help.

III. The Light-Ship

1. *Call attention to the light ship next. Notice where it is placed, and elicit from the children why a warning light is wanted near such a spot. Why put a light-ship there, and not a lighthouse?*

Tell that as **a lighthouse could not be built on these loose sands,** *a ship is placed there instead.*

Point out that this ship, like the lighthouse on the rocks, **has to brave all the fury of the storm,** *and hence show that it must be* **very strongly built.**

Tell that **the round iron cage** *at the top of the mast serves very well as a warning in the daytime. The sailors see it, they know what it means, and they steer their ship away from the dangerous place.*

2. At night, when this signal could not be seen, the men in charge of the light-ship **hang a powerful lamp on the mast** just below it, and this serves to warn the sailors of their danger.

The children will naturally be curious to know how this ship can be kept in its place, while ordinary ships are dashed about by the waves.

Tell that **a heavy anchor is let down into the water** *at the end of a very strong iron chain;* **this anchor sinks so deep into the sand** *that, even in the most violent storm,* **the ship cannot be torn away** *from its place.*

3. *Now will come the interesting moment for the children. With everything in readiness, nothing more is needed but to connect the loose wires with the other screw of the battery, and the lights will immediately flash out from all three positions.*

To complete the picture it would be well to move one of the little ships across the imaginary sea, to show how the lights enable them **to clear both the sandbank and the rocks,** *and at last* **enter the harbour in safety.**

IV. The Life-Boat

1. *Tell that, in spite of warning lights, ships are sometimes unable to battle with the fury of the storm, and then they are driven either on the treacherous sandbanks or the dangerous rocks, and wrecked.*

Picture the poor people struggling for life in the raging waters. What a cruel, awful death.

2. *Show the* **model of the life-boat,** *and describe briefly the principle of its construction by throwing the inflated bladder on the water.* **The bladder cannot be made to sink.**

The life-boat has large **air-tight chambers at the head and stern,** and others **all round the sides.** These air-tight chambers prevent it from sinking. **It will not sink,** even if it gets full of water and is crowded with people. It will even **right itself if it turns over.**

3. *Tell of the devoted bands of heroes all round our coasts, ready at a moment's notice to man the life-boat, and brave the dangers of the roughest sea, in the hope of saving some poor shipwrecked sufferers, who but for them must be swallowed up by the angry waves. Rough sailors they may look, but they are the bravest heroes, in spite of their rough appearance.*

Some one or other of the deeds of heroism, which are constantly being recorded, would form a fitting close to the lesson.

Summary of the Lesson

1. **Lighthouses** are placed on rocks, and on the dangerous parts of the coast, to warn sailors of their danger.

2. **Light-ships** are placed on the sandbanks, because a light-house could not be built there.

3. The light-ship is kept in its place by strong chains and anchors, which sink into the sandbank and hold it fast.

4. The lighthouses and light-ships are **the lamp-posts of the sea.**

5. **A life boat** has air-tight chambers at the head and stern, and all round the sides. It cannot sink ; it will right itself if it turns over.

Lesson VII

MAGNETS

The following articles will be required for illustration : two or three knitting-needles, one of which has been magnetised as shown in the lesson, a few common sewing-needles, a flat cork, a basin of water, a magnetic toy-duck, a small horse-shoe magnet, and a bar-magnet ; some iron filings ; a magnetic needle on a stand.

I. Introduction

Some time ago I promised to tell you about the sailors' wonderful compass, which helps them to find their way in any direction on the sea, when they have nothing else to guide them. But before I can talk about the compass itself, I want you to watch, and try to understand, a few experiments.

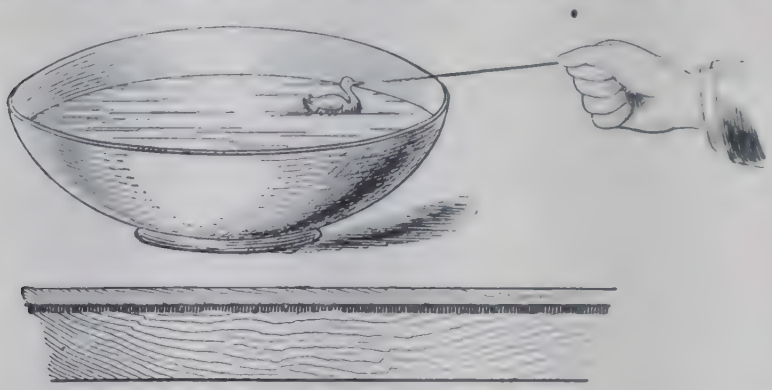
II. Magnets draw Iron and Steel

1. *Fix a small sewing-needle on a flat piece of cork, and float it in a basin of water, side by side with one of the magnetic toy-ducks. Now bring one end of a magnetised knitting-needle near each of them, and let the children observe that* **the cork and the bird follow the knitting-needle** *wherever it leads.*

Repeat with an ordinary knitting-needle—one which has not been magnetised. **This has no power to move the things,** *even when we touch them with it.*

Repeat once more with **the horse-shoe magnet,** *and*

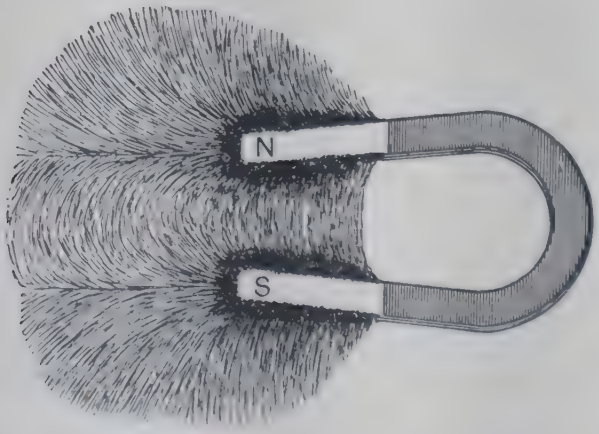
notice that the result is the same as with the first of the



knitting-needles. **The duck and the cork follow wherever it leads.**

2. *The horse-shoe magnet is a very common toy with most children, although they probably know it by its more familiar name*—**lodestone**. *No doubt some of those in the class have watched it pick up pen-nibs, needles, small nails, and things of that sort.*

Tell its other name—**magnet**—*now, and explain that magnets have* **the power of drawing towards themselves things made of iron and steel.**



3. *Illustrate this further* (*a*) *by holding the magnet over a saucer filled with iron filings, and* (*b*) *by plunging it boldly*

into the filings. Then lead the children to tell, from what they have seen, why the magnet drew the cork and the toy-duck after it.

Bring one of the children to the front now, and let him repeat the experiment with the magnetised needle.

This knitting-needle you see again draws the cork and the bird after it, just as the magnet did.

What does that lead us to think? **The needle itself must be a magnet.**

4. Let us try again with the other one. Is that a magnet too? No; it is **not a magnet. It cannot draw the iron and steel** after it.

Suppose we make it into a magnet then.

Produce **the bar-magnet.** *Show that it acts exactly as the other magnet did when it is brought near the floating needle and the iron bill of the bird.*

Place the knitting-needle on the table, and stroke it carefully from one end to the other with the bar-magnet, **taking care to raise the magnet each time,** *so that* **there are no backward strokes.** *This must be repeated several times.*

If now either end of the needle be brought near the floating cork and the bill of the duck, these things will follow it as it moves about. We have made **this knitting-needle into a magnet,** *exactly like the other.*

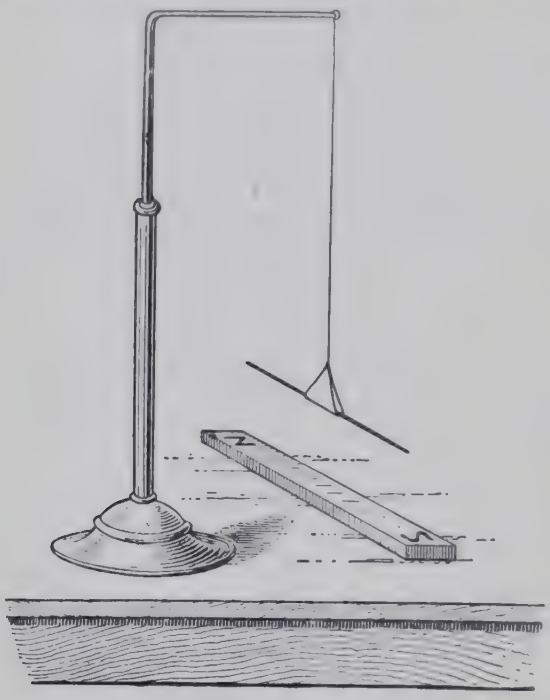
III. One Magnet draws another

1. *Place the bar-magnet on the table now, and suspend the newly magnetised needle* **in a little loop of thin, light paper,** *by means of* **a silk thread,** *so that it hangs about three or four inches above it.*

Touch the needle gently so as to make it swing round, and watch it till it comes to rest. Observe that it then hangs **exactly in a line** *with the bar-magnet below it.*

Now move the bar-magnet slowly round into other positions,

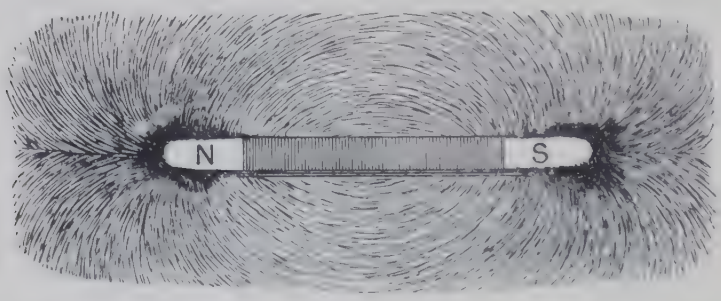
and show that, as it moves, **the needle swings round too,** *and each time comes to rest again exactly in a line with it.*



2. What do we learn from this? We learn that **the bar-magnet draws the needle-magnet** towards it.

But why should the ends of the needle always point to the ends of the bar-magnet? Perhaps we can find this out too.

Place the bar-magnet on a sheet of paper and sprinkle iron filings over it. Notice that the filings cling



in a thick bunch round each end, *and that there are very few in the middle of the bar.*

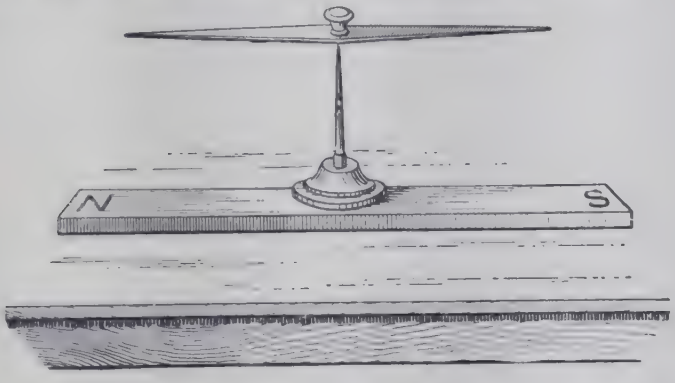
What would this lead us to think? That all parts of the magnet do not draw things with the same power. **The ends seem to have more power** to draw the iron filings towards them than the other parts have.

3. *Replace the bar-magnet now below the suspended needle.*

Watch the needle come to rest again, and explain that it always takes up this position in a line with the bar-magnet, because **all the strength of the bar-magnet is at its two ends.** *These two ends* **draw the two ends of the needle,** *and so make it point always in the same direction when it stops.*

Remove the suspended needle now, and in place of it produce **the magnetic needle on the stand.** *Set it on the table without saying anything about it for the present, but give the needle itself a slight touch with the finger, to show how easily it swings round on the steel point on which it rests.*

4. *Place the stand* **exactly in the middle of the bar-magnet** *now, as it lies on the table, set the needle swinging*



round again, and ask the children to watch it till it stops. Then explain as follows:—

This long, narrow, pointed piece of steel, you see, acts in exactly the same way as the knitting-needle did when we hung it up. It swings round and round for a time, and when at last it stops, **its two ends point to the two ends of the bar-magnet.**

5. *Explain that the knitting-needle would do the same if we could balance it on the steel point; but it would not be an easy matter to do that, and so we always use* **a flat piece of steel** *like this, instead of a needle.*

Show how it is made to balance on the pivot. Dip it into

the iron filings, and test it by bringing it near the floating cork and the duck, to show that like the needle **it is a magnet**.

Tell that although it is not at all like a needle in appearance, **we still call it a needle**. *Its proper name is* **the magnetic needle**.

IV. The Earth a Great Magnet

1. *Remove everything from the table now except the magnetic needle. Set the needle itself rotating, and call upon the children to watch it as before.*

When it has come to rest, notice the direction in which it points. One end of the needle is now pointing **to the north,** *the other* **to the south part of the room**.

Stick a piece of coloured paper on the end of the needle which points towards the north, and set it rotating once more. Observe that when it comes to rest again, **this end still points towards the north**.

2. *Move the stand round now into various positions, and test the needle again and again.*

Each time the needle stops, **the same end points in the same direction—north**. We must find out the reason for this.

How does the needle act when we place the bar-magnet under it? The two ends of the needle point in a line with the two ends of the bar-magnet.

Why? Because **all the strength of the bar-magnet is in its two ends**. One end of the magnet draws one end of the needle; the other draws the opposite end.

3. But there is no magnet on the table now to draw our needle. Why should it always point in this same direction—with **one end towards the north,** and **the other towards the south?**

Explain that **the earth itself is a great magnet,** *and that it draws the needle towards it—that like the bar-magnet*

all its strength is in its two ends, *which are in* **the north and south**—*and that this is the reason why the needle on the table* **always points in this one direction** *if left to itself.*

Summary of the Lesson

1. **Magnets** draw iron and steel towards them.
2. One magnet will draw another magnet towards itself.
3. All the strength of a magnet is in its two ends.
4. One end of the magnetic needle always points to the north, the other end to the south.
5. **Our earth is a great magnet.** All its strength is in its two ends—north and south. They draw the two ends of the needle towards them.

Lesson VIII

THE COMPASS

Provide for illustration: the magnetic needle, the school compass, and a small ship's compass if possible; and have in readiness three paper circles, one showing the four cardinal points, another showing those and the four intermediate ones—N.E., N.W., S.E., S.W., and another showing the whole thirty-two points.

I. Introduction

1. *Commence by leading the children to tell the various ways we have of finding those four important points*—**north, south, east,** *and* **west.**

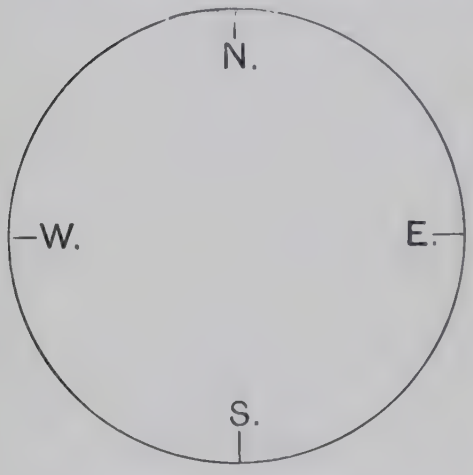
Elicit, by means of two or three minutes' practice, that it is only necessary **to know one of these points,** *and we can then easily find all the rest—that when* **we face the north** *we have the* **south behind us,** *the* **east on our right hand,** *and the* **west on our left.**

2. *Lead them next to think of the weathercock. Elicit that in*

foggy weather *this becomes quite useless,* **because we cannot see it**; *and then remind them that even* **the sun and stars are often hidden** *in like manner behind thick clouds, so that they can then give us no help.*

3. *Now place the magnetic needle on the table, and when it has settled, proceed to elicit, from what the children already know of it, that this would make a better guide than any of the others.* **Day and night, and in all weathers, this needle always points to the north.**

4. *Take the paper circle with the four points marked on it, and lay it on the table, placing the needle-stand in the centre of it.*



The needle itself, after oscillating to and fro, settles at last in the usual position **with one end pointing to the north.** *Show that in order to find the other points we must* **move the paper circle round** *till the letter N. marked on it points in the same direction as the north end of the needle.*

II. The School Compass

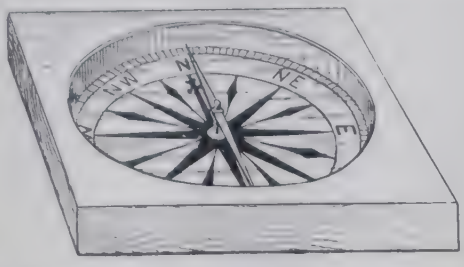
1. *As the school compass is usually constructed on this principle, it would be advisable to introduce it now. Show it and tell its name*—**a compass.**

Explain that the word **compass** *means* **a circle,** *and then (after first removing the needle) show that* **the bottom of the box is round** *or* **circular** *in form.*

Point out the four letters N. E. S. W. round the edge of this circular box, just like those round the edge of the paper circle on the table.

A mere glance at the other letters will be sufficient now. Promise to examine them later on.

2. *Call attention next to* **the small spike** *which stands up in the middle of the box. Produce* **the needle,** *and place it on the spike, and let the children see that when it comes to rest, one end of it, like one end of the other needle, points towards the north.* **It is a magnet, exactly like the other in every respect.**



Show that to find the other points we must now move the box round as we did the paper circle, till the letter N. on it **points in the same direction as the north end of the magnet.**

III. The Points of the Compass

1. What name do we give to the four points, **north, east, south, west?** We call them the **Four Cardinal Points.**

What does that mean? The **Four Principal Points.**

What do we learn from that? We learn that, as these are the **principal points,** there must be **other points** besides them.

Yes; there are other points. Let us see now what we can learn about them.

2. *Hand the box of the compass round the class, for the children to examine for themselves.*

There are so many points all round the circle, that I am afraid they would only puzzle you. Suppose we examine them a few at a time.

3. *Produce the card with the* **eight points** *marked on it.*

Show that **midway between N. and E.** *a new point is marked on this card, with the letters N.E. against it; and tell that* **N.E. means north-east.**

Call upon the children to point to the north and east sides of the room, and then midway between the two. Explain that this is the **north-east part of the room.**

Proceed to deal in a similar way with N.W., S.E., and S.W., and lay the card itself on the table to show the direction in which each points.

4. *It will be necessary to practise the children repeatedly in finding these eight directions; but* **they should not be called upon to learn any of the rest.**

It will be quite sufficient for them to know how these eight points are made into sixteen, and the sixteen into thirty-two, without attempting to learn their names.

When that is done, let them count the number of points on the compass itself. **These thirty-two points** *are called* **the Points of the Compass; the four points N. E. S. W.** *are the principal ones, and they are called* **The Cardinal Points.**

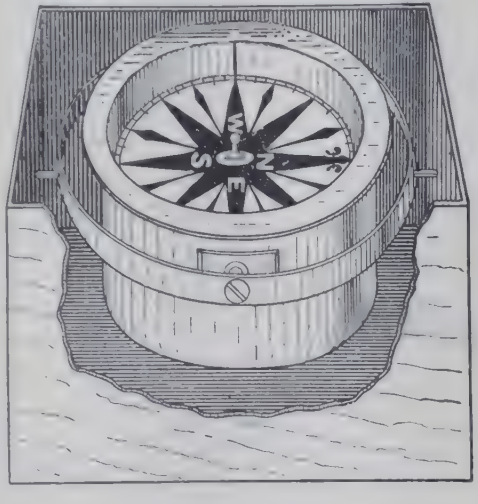
IV. The Ship's Compass

1. *Produce the paper circle on which the whole of the points are marked, fix it with gum or sealing-wax* **on the top of the magnetic needle** *with N. pointing to N., and show that when the needle moves round,* **it carries the paper circle round with it.**

Show the ship's compass now (if possible), and point out that in this there is **no needle to be seen.** *The card itself moves round just as our paper circle did,* **because it is fixed to the needle below it.**

2. *Tell that this is the kind of compass which sailors use at sea.*

It is sometimes called **the ship's compass,** and sometimes **the mariner's compass.** The word **mariner** is only another name for **a sailor.**



The other compass which we examined first is **a land compass.** The needle moves round by itself, and **the card is fixed at the bottom of the box.**

3. *Lead the children to tell again how people find their way with the land compass.*

They first **find the north** by noticing the direction in which the needle points, and then **they move the box round** till the N. on the bottom of the box is exactly under the north end of the needle. This gives them all the other points.

• 4. *Explain now very carefully how the ship's compass guides the sailors.*

The compass is **fixed on the deck of the ship**, so that **no part of it can move except the needle and the card which rests on it**.

It is always placed near the man who is steering, and on the top of the compass-box itself there is a very plain mark **in an exact line with the keel of the ship**.

If the man wants to steer the ship towards the west, he turns it round with the helm, **till the letter W. is in a line with the mark on the box**. He then knows his ship is going in the direction he wishes it to go.

5. *Explain briefly the great importance of the mariner's compass to the sailors on the sea. Remind the children that the sun and the stars can help them only in fine clear weather—that in foggy or cloudy weather, when the sailors cannot see the sun or the stars, they would be very likely to lose their way but for the compass, for they have nothing else to guide them.*

Tell that because of this sailors in the old times long ago never used to sail far away from the land; but now **no ship ever goes to sea without a compass,** *and the sailors* **can find their way** *with it wherever they may be, and* **in the darkest night** *as easily as in the daytime.*

Summary of the Lesson

1. The magnetic needle is the best of all guides, because it always points to the north, and then it is easy to find the other directions.

2. **A compass** is a round box, in the centre of which is a short spike, with a magnetic needle balanced on it.

3. The circle of the compass is divided into thirty-two equal parts. This gives us thirty-two points of direction. We call them **the points of the compass**.

4. The four chief points are north, south, east, west. We call these **the four cardinal points**.

5. In a land-compass the card, with compass-points marked on it, is fixed to the bottom of the box.

6. In **a mariner's compass** the card is fixed to the needle. We cannot see the needle itself. When the needle moves round it carries the card round with it.

7. The compass is always fixed to the ship, so that no part of it can move except the needle and the card which rests on it.

Lesson IX

MOUNTAINS AND TABLE-LANDS

The teacher should be provided with some damp sand, a large flower-pot, and either a very small cup, a wine-glass, an egg-cup, or a thimble for modelling purposes. The modelling tray with the prepared model of the mountain should be on the table covered up in readiness for the lesson.

I. Introduction

1. *Commence by leading the children to tell all they can remember of the nature of a hill. Elicit that—*

(*a*) A hill is a mass of land **rising high above the level country** round.

(*b*) The **bottom or foot** of the hill is called its **base**; the **top** its **crest** or **summit**; the **sides** the **slopes**.

(*c*) Most hills have **gentle slopes** and **smooth, rounded crests**.

2. *Illustrate this by reference to hills in the neighbourhood, and set one of the children to make a small sand model of a hill.*

Point out that from the summit of a hill we are able to look down on the housetops near. We find that we are **higher than the highest church steeple**.

3. *Tell that some hills are so high that* **a great many church steeples piled one above another** *would not reach to the top or summit of them.*

Those very high hills are called **mountains**. We might say **a hill is a very small mountain**, or **a mountain is a very large and high hill**.

Let the children compare the two in a simple way by moulding some damp sand in a thimble or an egg-cup, and a large flower-pot, and turning them out side by side.

To-day we are going to see what we can learn about mountains.

II. Mountains and Hills

Appearance.—1. *Explain, in the first place, that when we say a mountain is a very high hill we do not say enough.*

It cannot properly be called a mountain unless it is **upwards of 2000 feet high**. Below that height it is only a hill.

Explain, too, that the height of hills and mountains is always measured, not from the land at the foot, but **from the level of the sea,** *because the surface of the sea is like a level floor, and is* **the same in all parts of the world**.

2. When we say a mountain is 2000 feet high, we mean that, if **a great pole 2000 feet** in length could be set upright **on the surface of the sea,** the top of it (which would then be as high, say, as twenty church steeples one above the other) would **just reach the summit of that mountain**.

Tell that there are some mountains in the world **nearly 30,000 feet high**; *and explain that* 30,000 *feet measured in a straight line on the ground would reach* **between five and six miles**.

3. *Mention some place about this distance from the school, and lead the children to picture to themselves* **a pole of the same length set up on the sea-level**. *Ask them to try and compare this with the height of the church steeple, and also with a mountain* 2000 *feet high.*

4. The tops of these high mountains tower upwards to

such an enormous height that **they seem lost in the clouds.** We often speak of them as the **cloud-capped mountains**, because the clouds cover their heads or summits like a cap.

5. *Point out, in the next place, that mountains besides being higher than hills, are* **much more steep and rugged.**

The country all round the mountains is usually hilly, and the mountains themselves spring from this hilly ground. But it is easy to see from their appearance, without noticing the height, where the mountains begin, for instead of the smooth, sloping hill-side we find **huge masses of rock piled high, one above another,** with **deep clefts or chasms** between them. These make it very difficult to climb a mountain.

The snow-line.—1. *Tell that people who go up in a balloon always take thick coats and wraps with them, because* **the higher they go the colder they find the air** *all round them. If they took* **water** *with them in the car* **it would freeze,** *and at last, as they get higher still, it becomes so intensely cold that,* **the breath freezes as it leaves their mouth and nostrils.**

Remind the children that it is in those intensely cold regions of the air that **snow** *and* **hail** *are formed.*

Sometimes it is **the vapour of the clouds that is frozen,** and this forms snow.

Sometimes **the rain-drops freeze into round balls of ice** as they fall through the air, and they become hail.

2. *Tell that, in the same way, it is so cold on the tops of these high mountains, that they are* **covered with snow all the year round**—*summer as well as winter.*

Beyond a certain height we find **nothing but snow,** *for* **the snow never melts there.**

The line on the mountain-side where the snow begins is called **the snow-line.**

These white, snow-clad mountains towering up to the sky look **very grand, very wonderful,** and **very beautiful,** but many people lose their lives every year in trying to climb to the top of them.

Now will be the time to uncover the model, and spend a few minutes in recapitulating what has been taught, contrasting the mountain itself with the hills at its foot.

Ranges and Groups.—1. Mountains and hills usually occur in **a long row or line,** with their bases touching each other. We then call them **a range** of mountains, or **a chain** of mountains.

Lay a piece of chain in a line on the table to show what is meant, and point out that in a mountain chain each mountain may be looked upon as forming **one of the separate links.**

Sometimes the mountains, instead of extending in a line one after the other, **stand close together in a cluster.** We call them **a group of mountains.**

2. *Place a number of children of different heights first in a line along the room, and then in a cluster, to illustrate what is meant by the two terms.*

Notice as they stand together that one child here and there is much taller or higher than the rest. Tell that it is just so with the mountains, whether they are arranged in a chain or a group.

Here and there **some of the mountains tower up high above the rest,** and we call them **mountain peaks.** They are the highest mountains in the range or the group, and **each one is known by some special name.**

Mountain Valleys.—1. *Lead the children in the next place to tell that, whether the mountains occur in chains or groups, there must be* **hollows between them,** *and that the proper name for* **the hollow place between hills or mountains is a valley.**

Turn to the model once more, and call attention to the **wide, open valley** *stretching between the two mountains.*

Contrast this with the **deep, narrow cleft** *on the other side. Tell that this too is a hollow place between the sides of the mountains—it is* **a kind of valley,** *but because it is* **deep and narrow** *it is known as* **a mountain gorge,** *or* **a ravine.**

2. *Call attention to the bridge which crosses the ravine, and the narrow ledge leading from it along the side of the mountain. Tell that people who live in mountainous countries have to travel as well as they can across the mountains, and that this narrow ledge represents* **the dangerous roads, along which they travel.**

It is called **a mountain pass.** In many places these roads are only wide enough for one person to walk.

A glen is **a deep, narrow valley** between two mountains or hills, but unlike the ravine, it is **thickly wooded,** with trees on both sides.

III. Table-Lands

1. Let us leave the mountains and hills now, and think about the **low, flat land.** What name do we give to this? We call low, flat land **a plain.**

Explain that in some places the land is flat, but instead of being low like a plain it is **raised high above the level of the sea.**

Illustrate by reference to the floor and the table-top, and tell that those **high plains** *are called* **table-lands.**

2. *Remove the upper part of the model mountain now, and proceed to show what the actual table-land is like.* **A table-land is like a mountain with the top cut away.**

Point out that the land rises in every way **like the side of a mountain,** *but it is unlike the mountain, because it does not form a lofty peak.* **The top of this high land is flat**—*not of course smooth and level like the table; but there*

are **no jagged peaks** *rising from it, and therefore there are* **no valleys.**

A table-land is sometimes called **a plateau.**

Summary of the Lesson

1. **A mountain** is a very large and high hill. It must be 2000 feet high to be called a mountain. Some mountains are nearly 30,000 feet high.

2. The height of hills and mountains is measured from the level of the sea.

3. Above **the snow-line** the mountains are covered with snow and ice all the year round.

4. **A range of mountains** or a **chain of mountains** is a long row or line of mountains.

5. **A group of mountains** is a cluster of mountains standing close together, but not in a line.

6. **A mountain peak** stands up high above all the other mountains in the range or group.

7. **A mountain valley** is a broad, open hollow between the mountains.

8. **A mountain gorge** or **ravine** is a sort of valley between the mountains, but it is deep and narrow.

9. **A mountain pass** is a road over a mountain.

10. **A glen** is a deep, narrow valley, thickly wooded with trees.

11. **A table-land** or **plateau** is flat land raised high above the level of the sea.

N.B.—*This lesson entails an unusual amount of memory work. The time, therefore, of the next lesson, and perhaps of the following one, would be well spent in recapitulation. The children as usual should illustrate their own answers by modelling in clay and sand.*

Lesson X

THE SNOW-CLAD MOUNTAINS

Articles for illustration: a lump of ice and a large bowl of water; some drawings of snow-flakes magnified, the modelling tray with the model of the glacier; a picture of icebergs at sea.

I. Snow and Ice

1. *Show a piece of ice. Observe that it is a* **hard, transparent, colourless solid,** *like a piece of glass. Compare it with snow, which is* **perfectly white, loose,** *and* **feathery.**

Lead the children to tell that snow is the **frozen water-vapour of the clouds.**

Explain that in the clouds this water-vapour is **mixed with air,** *and that when the vapour is frozen* **it is the air** *in it* **which gives it its white colour.**

2. *Show drawings of snow-flakes as they appear under the*

magnifying glass, and point out that they are all **six-sided figures.** *Each one is formed of* **six little ice needles.**

Lead the children now to think of their snow balling games. Remind them that if they squeeze the snow very tightly in their hands, it becomes changed into ice.

N.B.—*It is needless to observe that if the weather conditions permit, this must be done, not described.*

Why is the snow changed into ice? In squeezing the snow **we press out all the air,** and cause the particles of ice to cling close together into a solid mass. **When the air is forced out, the white colour disappears.**

II. A Glacier

1. I want you now to think over our last lesson about the mountains.

If you were going up a mountain what sort of clothing would you put on? **Thick, warm clothing.**

Why? Because the higher we go up the mountain **the colder it becomes.**

What would you find there when you reached a certain height? **Snow.**

How do we describe that part of the mountain where we first find the snow? We call it **the snow-line.**

What do you understand by the snow-line? The snow-line marks that part of the mountain above which there is **snow all the year round.**

2. *Tell that it is so intensely cold on the tops of these mountains that* **snow falls very frequently and in immense quantities,** *and as the snow cannot melt, one layer is quickly covered up by another, so that* **every valley and ravine** *between the mountain peaks* **is filled up,** *and it looks like* **one immense field of snow.**

3. *Now remind the children of the snow-ball, and lead them to tell what must be the effect of the constantly increasing mass of snow on the layers underneath.*

The weight of the mass above **presses heavily** on that which is below, and **forces all the air out of it,** and so changes it from snow into solid ice. **Instead of fields of snow they become fields of ice.**

4. *Point out next that all these mountain valleys of course slope downwards, and that the pressure of the constantly falling snow is always increasing from above, and in this way elicit from the class that* **the mass of ice must be forced down the slope** *little by little.*

The fields of ice **become rivers of ice,** for they actually move down the mountain slopes. **These rivers of ice are called glaciers.**

5. *Explain that as the glacier slides down the slope, the lower part of it reaches warmer regions, and* **then it begins to melt.**

The water from the melting ice flows down the sides of the valley, and **this helps the glacier to slide more easily.**

Tell that **the glacier** *after all* **moves very slowly**—*never more than* **one or two feet in the day,** *often not more than* **a few inches.**

6. *Show the model now, and let the children examine it carefully.*

Call attention to the water which flows from the lowest part of it.

This is the **water from the melted ice.** What becomes of it?

Tell that this, like all other water which flows down from the hills and mountains, forms a river. **Melting glaciers form the sources of many rivers.**

III. An Avalanche

1. *Remind the children that after a heavy snow-storm, we*

often see, when the thaw sets in, the whole mass of snow slide down from the roof of a house.

Picture the same thing taking place on the side of the mountain, but on such an immense scale that the mass of falling snow is enough to overwhelm a whole village in the valley below.

2. The snow, as it is forced onwards by the pressure from above, moves easily enough down the sloping sides of the mountain, till it comes to some part steeper than the rest, and then **it falls with a rush, and a roar like thunder,** into the valley below.

A mass of falling snow like this on the mountain-side is called **an Avalanche.**

Tell of the dangers of the avalanche to travellers crossing the mountains.

IV. An Iceberg

1. *Produce the piece of ice, and let one of the children put it into a vessel of water—a tall glass vessel of some sort would be best if it could be obtained.*

What do you observe? **The ice floats** on the top of the water.

Push it down. What happens when it is left to itself? **It flies up** and **floats on the top** again **like a cork.**

What do we learn from this? We learn that **ice is lighter than water,** because it floats.

2. *Now show the picture of the iceberg. The first thing to surprise the children will be the ship. They will see from this that we have left the snow-clad mountains, the glaciers and avalanches, and are on the sea again.*

What is that great, green, glittering mass towering above the ship?

Tell that it is **a great mass of ice** *floating in the sea. It is so big that we call it* **an ice mountain.** *It is* **a floating mountain of ice.**

Its proper name is **an Iceberg**—the word "**berg**" means "**mountain.**"

3. In some parts of the sea sailors meet with **hundreds of these great floating ice mountains.** Let us see what they are, where they came from, and why they are found floating in the sea.

Tell that they are simply **pieces chipped off,** *or* **broken off from some enormous glacier,** *which moved slowly down some mountain slope, and at last toppled over into the sea.*

4. The glaciers from which these icebergs come are always formed in the **cold, frozen regions of the world,** where there is **ice and snow** not only on the mountain-tops, but **everywhere.**

When the great mass of ice falls into the water, it floats away out to sea.

Think of it as it floats about in the water till it comes to some warmer part of the world.

What would be likely to happen then? **The ice would melt away.**

5. *Explain that this is exactly what does happen. Turn to the picture once more, and call special attention to the* **ragged appearance of the iceberg.**

This one is **melting little by little.** After a time these great overhanging masses break away and fall into the sea, and so by degrees **the whole of the iceberg disappears.**

Tell how dangerous the icebergs are to ships on the sea, and how careful the sailors are to keep out of their way if they can.

6. *Call attention once more to the lump of ice floating in the water. Point out that the part below the water is much greater than the part above the surface. Explain that it is exactly the same with the iceberg.*

The great mass of ice may tower hundreds of feet

above the surface of the sea, but **the part below the water is many times greater than the part above.**

Summary of the Lesson

1. **A Glacier** is a river of ice which moves slowly down the side of a mountain. It is formed from the snow that falls on the mountain.

2. That part of the glacier which is below the snow-line is always melting. The water from the melting ice of glaciers forms the sources of many rivers.

3. **An Avalanche** is a mass of snow falling down the side of the mountain.

4. **An Iceberg** is a mountain of ice floating in the sea. It is only a piece chipped off some great glacier. It floats because ice is lighter than water.

Lesson XI

BURNING MOUNTAINS

Have the modelling tray in readiness, with the volcano and the geyser prepared and arranged in accordance with the instructions given, so that when the time comes, each may be made to work as required. Provide also specimens of lava and pumice-stone for inspection during the lesson, and some small pieces of cork for the basin of the geyser, and to represent the masses of rock which are hurled up from the crater of the volcano.

I. Appearance of the Mountain

1. *Uncover the model, and at once proceed to call attention to the mountain, without saying anything for the present as to the name—volcano.*

Notice that, unlike most other mountains, this one **does not form part of a range or a group,** *but seems to rise up directly from the level country round, and* **stand there alone.**

Notice next its peculiar shape. It has **no jagged, rocky**

peaks towering up to the sky, with broad valleys and deep ravines between them, but its sides and top have a **smooth, rounded appearance.** It looks **like a cone** or a sugar-loaf **with the top cut off.**

In illustration of what is meant show the cone used in the drawing lessons, or better still (if possible) show one that has been truncated.

2. *Turn once more to the model, and point out in the next place that the top of the mountain is not flat.*

It is **hollowed out in the form of a basin,** and this hollow, basin-like cavity is known as **the crater** of the mountain.

Explain that in some of the actual mountains **the crater is several miles across,** *and of immense depth, and* **the sides of the huge basin** *all round are formed of* **steep, lofty, rugged rocks.**

3. *Tell that the strangest thing about these mountains is, that there is almost always either* **flame and smoke,** *or else a* **dense volume of steam,** *pouring out from the crater; and travellers who climb the mountain-side to see what the crater is like, find the* **ground beneath their feet quite hot,** *as though the inside of the mountain itself were on fire.*

These mountains are actually on fire inside, for they are **burning mountains.** We call them **volcanoes.**

Some volcanoes are **always blazing and smoking** night and day. **Others are quiet for a time,** and nothing is to be seen but some steam rising from the crater, like the steam from a railway engine, till all of a sudden they break out, and we say there is **an eruption.**

II. The Volcano in Action

1. *Tell that some days before an eruption takes place,* **low rumbling sounds are heard** *deep down in the earth, the whole mountain seems to* **tremble and shake,** *and steam pours out from the crater in huge puffs.*

Then without a moment's warning **an awful explosion**

takes place; dense volumes of **flame and smoke** *burst out from the crater; huge masses of* **rock, stones, cinders,** *and* **ashes** *are hurled up miles high into the air; and streams of* **boiling, melted rock, or lava,** *flow down the mountain-sides, and spread themselves over the country for miles round, scorching and burning up everything they touch.*

2. *Now will be the time to set the model in action by connecting the wires, and so give the children a very graphic and realistic representation of the actual scene.*

Picture the sky lighted up with the lurid flames, and at the same time darkened for miles round with the **dense clouds of ashes and fine dust,** *which for days and weeks after the eruption settle on everything like a black pall.*

This gradual fall of rock, stones, cinders, ashes, and dust explains **why the volcano is always cone-shaped.**

The heavier masses of rock and stone which are hurled upwards into the air either fall back again into the fiery furnace whence they came, or else roll down the slope of the mountain; but the smaller stones, cinders, and ashes as they fall **are piled up in circular layers** all round the actual cone. **The cone itself grows larger** in fact after each eruption.

3. *Show a specimen of lava, and let the children examine it for themselves. Tell that this lava was formed from rocks deep down in the earth.* **The rock was melted by the intense heat** *inside some volcano, and in its molten state it flowed down the mountain-side and over the land near,* **like a river of boiling pitch.** *It was many years before it cooled and became solid again as we see it now.*

N.B.—*The lava stream, as it flows along, cools very rapidly on the surface, for in a few days after the eruption it is hard enough to walk upon. But years afterwards, if an iron spike is driven into it, the inside is found to be very hot still, and clouds of steam pour out from it, although the outer surface may be quite cold.*

4. *Hand some pieces of* **pumice-stone** *round the class next for inspection, and lead the children to tell from their own observation—*

(*a*) That it is a **hard, brittle substance,** for it breaks with the blow of a hammer; and

(*b*) That it is **very light and spongy-looking.** Some kinds are so light that they **float in water.**

5. *Tell that as the black, boiling river of lava flows along,* **patches of loose, frothy scum** *rise to the surface and float there, because they are lighter than the liquid lava itself. This light, frothy scum is the first to cool, and* **when cool it is known as pumice-stone.**

Call attention to the holes in a piece of bread. Point out that these were formed by the steam from the moist dough during the baking, and show the parallel in the case of the pumice-stone.

This substance, as well as the lava itself, in the molten state, deep down in the earth, was **full of steam and other vapours,** and as it cooled these vapours formed the little holes which we see in it.

III. Volcanic Islands

Tell that sometimes a volcano is formed in the bed of the sea. Picture an eruption from such a volcano.

What must become of all the rock, stones, cinders, ashes, and lava from it? It must all sink down through the water again, and **form a piled-up heap there,** and this would in time **become a mountain in the sea,** because it would get bigger and bigger after every eruption.

When a mountain in the sea peeps up above the surface of the water, what do we call it? **An island.**

This explains how new islands are constantly forming in the sea. They are **formed by volcanoes** under the sea, and we call them **volcanic islands.**

IV. A Geyser

Tell that in some parts of the world, in place of volcanoes with their flames, smoke, ashes, and molten rock or lava, **boiling springs** *are found.*

These boiling springs are called **geysers.** They send up **jets of boiling water and steam** to the height of a hundred, and often a hundred and fifty feet.

Just before the water bursts up from the earth, **low, distant, underground rumblings** are heard, like those which give warning of an eruption of a volcano, and the ground all round **shakes and trembles violently.**

Then there is usually **a loud explosion,** and the steaming hot water mounts upwards **like a jet from some immense fountain,** carrying stones and great pieces of rock up with it.

Show this in the model with pieces of cork substituted for the rock and stone.

V. How they are Formed

N.B.—*Some explanation of these phenomena will be necessary at this stage, but the teacher must bear in mind the capacity of these young children and the scope of the previous teaching.*

1. *Remind them that we have already spoken of the sun as a great ball of fire, and explain that ages ago* **this earth** *on which we live* **was a burning mass like the sun.** *Since then it has been cooling little by little, but like the lava from the volcano it is only the outside which has cooled.* **The inside of the earth is still very hot.**

2. It is the **intense** heat deep down in the inside of the earth which produces not only the **flames and smoke and lava** of the volcano, but also the **boiling water** of the geyser.

Remind them too of the bladder of air held in front of the

fire, and lead them to tell that the heat of the fire made the air inside the bladder swell up, so that it wanted more room.

Tell that heat causes not only air but almost everything to swell up, and explain that the **hot vapours and steam** *inside the earth* **swell up** *with so much force that, they* **burst holes in the earth itself,** *to form these volcanoes and geysers, and hurl great masses of rock and stone miles high into the air.*

Summary of the Lesson

1. **A volcano** is a burning mountain, which throws out smoke, flames, ashes, cinders, and lava.
2. **The volcano** is usually a cone-shaped mountain.
3. In its summit there is a deep hole—**the crater**—which is often several miles across.
4. **The crater** is the chimney out of which the smoke, flames, ashes, etc., are poured.
5. **Pumice-stone** is the hardened scum which floats on the top of the boiling lava, as it flows down the mountain-side.
6. **Volcanic islands** are formed by volcanoes in the bed of the sea. These volcanoes throw up such heaps of rock, stone, ashes, and lava that they form a sea-hill, which at last peeps above the water, and forms an island.
7. **Geysers** are boiling springs which spurt up out of the ground sometimes to the height of 100 feet and more.

N.B.—*The usual recapitulation should follow.*

Lesson XII

RIVERS (First Lesson)

Have in readiness the modelling tray, with the model of the upper reaches of a river and its feeders properly arranged. A large sponge, a board or rough tray of some kind, some clay and sand, and a picture of a river will also be required.

I. Introduction

1. *Uncover the model, and commence by leading the children to tell all they can of the nature of a river, so far as it has been dealt with in the earlier lessons. They will have no difficulty in telling—*

(*a*) That a river is **a running stream of fresh water;**

(*b*) That it is **fed by springs** and **by the rain** which falls on the sloping sides of hills and mountains;

(*c*) That **it flows downwards** because it is always seeking the lowest level;

(*d*) That, as it flows, it receives the waters from other smaller streams, which are called its **feeders** or **tributaries;**

(*e*) That **it grows broader and larger** continually; and

(*f*) That it at last **loses itself in another river or the sea.**

2. *The nature of the source of the river may now be further illustrated as follows:—*

Soak a sponge thoroughly in water and stand it on a small board or a slate placed in a sloping position. Let the children observe that after a while the water trickles very slowly indeed from the sponge. **The sponge holds the water.** *Now pour some more water on the sponge from time to time, and point out that, as this is done, there is* **a constant stream flowing down the slate.**

Tell that the earth acts very much like the sponge in this respect. **The spongy ground holds the rain** *as it sinks in, and only lets it flow out gradually.*

In this way **the water from one shower of rain** is sufficient to keep the spring running **till the next shower comes.**

3. Some rivers are fed without any springs whatever,

with water which flows direct **from marshy, spongy land.**

Remind the children too of the snow-clad mountains and their glaciers, and lead them to tell that some rivers are formed and fed by **the water from the melting ice of the glaciers**; *these rivers have no springs at their sources.*

II. Watersheds

1. *Call the attention of the children to the rain which falls on the roof of a house.*

It runs **down both the sloping sides** *into the gutter at the edge of the roof.*

Show that the top ridge of the roof **separates** *or* **parts the rain** *as it falls, and makes it flow in these different directions,* **because water cannot flow up.**

2. *Point out that we may notice* **the same kind of thing in the roadway** *after a heavy shower, and lead the children to tell from their own observation—*

(*a*) That the roadway is always **highest in the middle,** and slopes down towards the gutter on either side.

(*b*) That the rain which falls on this high part **runs away in little streams,** some down one slope, and some down the other.

(*c*) That as these little streams flow down, **they run one into another** and make larger streams, which flow at last into the gutter at the side of the roadway.

3. *Point out that the middle of the roadway, like the ridge of the roof,* **parts** *or* **separates the water,** *and makes it flow in these two directions.*

Apply this to the rain falling on hills and mountains, or the water flowing from the melting glaciers, and the children will have no difficulty in grasping the rest.

4. Wherever water falls it must flow in streams **down the sloping ground.**

Hills and mountains therefore **separate,** or **part,** or **shed these streams,** and **make them flow in different directions.** High ground of any sort must do the same, and we call it a **Water-parting** or a **Watershed.**

Call upon the children now to give examples of watersheds in the model before the class.

III. River-Basin

1. *This last exercise should naturally prepare the way for the next step. Turn once more to the model, and point out that the country through which this river and its tributaries flow,* **is shut in by high land on almost all sides,** *and that the streams all flow down the different slopes to join the main stream.*

Compare the ridges of this high land all round to the **edge or rim of a saucer or a basin,** *and tell that the whole of the land enclosed by this high ridge is called* **the Basin of the river,** *or the* **River-basin.**

2. *Remind the children once more that all the rain which falls on this side of the high ridge* **must flow down the slopes in streams,** *either directly, or from springs, and so it finds its way into the main stream, and is carried out to the sea.*

Hence the rain, instead of lying where it falls to make the land a useless swamp, is carried away to the sea. We say that the river and its tributaries **drain the land;** and the name **river-basin** is given to all **the land which the river and its tributaries drain.**

IV. The Banks of a River

1. *Refer to the model once more, and call attention in the next place to the land on either side of the stream.*

We call the land by the side of the river **the river bank,** and of course **every river has two banks.**

They are known as the **right** and **left bank,** according as they are on the **right** or **left** of a person who stands **with his back to the source.**

Call upon the children to point out the right and left banks of some of the streams in the model.

2. *Picture the river at its source among the hills*—**a mere thread of water** *rippling over its pebbly bed—a boy could easily jump from one bank to the other. Follow it in its course down the sloping ground,* **always increasing in width and depth, always seeking a lower level.**

What kind of stream would you expect it to be? **A very swift-flowing stream.**

V. Waterfalls

1. *Tell that on its way the river may often come to places where there is* **a more rapid fall in the ground** *than usual. This only helps it in its onward course,* **for the water dashes over the rocky ledge,** *falls foaming to the lower level, and then flows on more swiftly than before.*

We call the place, **where the river leaps over a ledge of rocks** in this way, **a waterfall or a cataract.**

2. *Tell of the mighty* **Falls of Niagara,** *where a great river leaps over a ledge of rocks* **more than 150 feet high,** *and falls to the bottom* **with a noise like thunder,** *filling the air all round with clouds of spray.*

The rivers in our land have no great waterfalls like this, but there are many small ones. **A small waterfall** is sometimes called **a cascade.**

3. *Lead the children step by step to deduce for themselves—*

(*a*) That waterfalls can occur **only in hilly and mountainous places.**

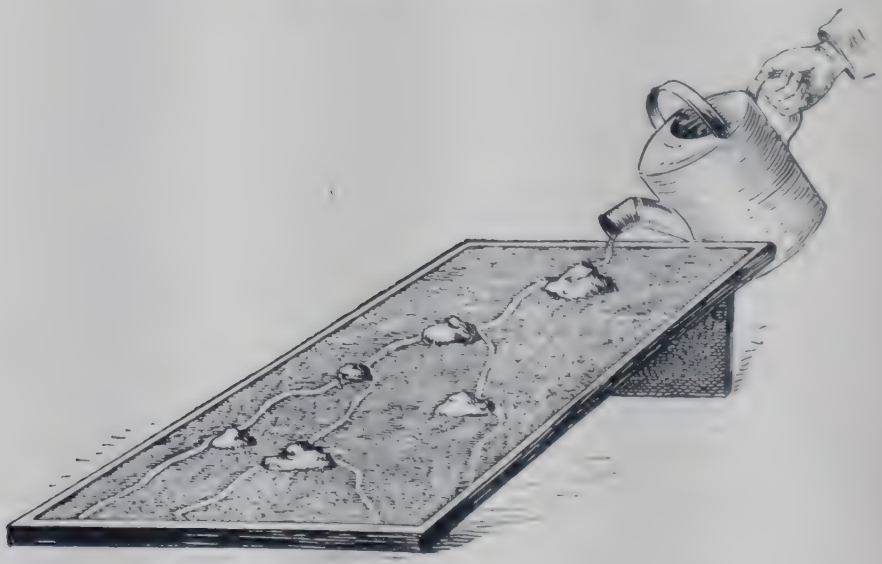
(*b*) That when the river reaches the low plains, it is no longer a rapid stream, but **creeps along slowly.**

Illustrate this by pouring some water on a slate first in a sloping position and afterwards held level.

VI. Why Rivers Wind about

1. *Direct the attention of the children once more to the little streams of water which they see in the roadway after a heavy shower, and lead them to tell—*

(*a*) That although these streams all flow down the



sides of the road towards the gutter, **they do not flow in straight lines.**

(*b*) That every stone—every rough place in the road of any sort—**turns them out of their course,** and makes them **wind about** in different directions.

2. *Illustrate further as follows: Place a few pieces of clay here and there on a board, and then spread sand over the other part, so as to cover it to the depth of about half an inch. Let the board be now placed in a slightly tilted position, and pour*

water gently on the higher part of it, calling upon the children to observe what takes place.

The little stream of water flows down the sloping board in a straight line, till it meets with the clay, and **it then turns aside and flows in another direction.** It can wash a passage for itself through the loose sand, but it cannot do so with the clay, and so **it has to flow round it.**

3. *Notice that this occurs again and again, as the stream meets with other pieces of the clay.*

Explain that it is exactly the same with a river:—

The river makes its own bed or channel as it flows along.

It can only do this **by washing away the earth.**

When the water meets with any material which it cannot wash away, **it flows round it.**

Summary of the Lesson

1. **A river** is a stream of fresh water, which runs over the land, and loses itself at last in the sea, or in another river.
2. **The source of a river** is its beginning.
3. **The tributaries** or **feeders** of a river are the small streams which flow into it.
4. **A river-basin** is the land from which a river and its tributaries get all their water.
5. The river and its tributaries drain this land.
6. **A watershed or water-parting** is the high ground which separates two river-basins.
7. **The banks** of a river are its sides.
8. The right and left banks of a river are on the right and left of a person who stands with his back to the source.
9. **Waterfalls or cataracts** are formed when a river dashes over rocks.
10. A small waterfall is called a **cascade.**

N.B.—*This lesson as usual should be followed by one devoted to the work of recapitulation and modelling in clay and sand by the children.*

Lesson XIII

RIVERS (Second Lesson)

Provide for illustration: some sand, clay, garden-mould, and pebbles (large and small); a large glass bowl of water, and a beaker, or a common tumbler. The modelling tray, with the model of the lower reaches and mouth of the river properly arranged, should also be in readiness. The teacher will prepare the delta with sand and clay as the lesson proceeds.

I. The Flow of the River

1. *Commence by referring once more to the appearance of the roadways after the rain. Point out that, when it has been raining very heavily, we often see quite a wide stream of water rushing along the gutter at the side of the road.*

Ask the children, when they next see such a stream, to throw into it some little pieces of cork or paper, and observe what happens.

The pieces in the middle of the stream will **float along very quickly,** and soon leave behind those that are near the sides.

2. Why do the pieces of cork and paper move at all? They are **carried along by the water** as it flows.

Then as some of them move more quickly than others, what must we think? The water in the **middle of the stream must flow faster** than that at the sides.

Tell that this is quite true, and that it is as true of the river and other streams as it is of the stream of water in the gutter.

3. *Lead the children, step by step, to deduce the reason for this.*

The water at the sides of the stream **washes and**

presses against the solid earth of the banks as it flows along; it would spread out beyond the banks if it could, but they keep it back. It is the struggle between the water and the banks which **delays the flow of the stream at its sides**; but there is nothing in the middle of the stream to prevent the flow of the water.

4. *It would be better of course if a suitable day could be chosen for this lesson, so that the children might observe for themselves, instead of being told. It would be better still, where the locality permits, to take the children to an actual stream for observation.*

Point out, and show by the same reasoning, **why the flow is always faster on the outer,** *than on the inner bend of a winding river.*

II. The River-Bed

1. *Pass on next to consider* **the state of the road itself,** *after the rain has all cleared away. Lead the children to tell from their own observation how, in some places, the streams made by the heavy rain* **tear up the road into grooves and channels,** *and* **wash the mud, sand, and pebbles** *away to a distance.*

Tell that this observation of the road after the rain will help us to understand many things about **the bed of the river—the groove or channel in which the river flows**—*for the flowing water of every stream and every river* **tears up its bed,** *and* **washes away mud, sand, and stones** *to a distance, just as the rain-streams do in the roadway.*

2. *The following experiments will make this all very clear:—*

Put a lump of salt in a tumbler of water, and stir it up till it disappears.

Elicit that **the salt dissolves**; *that it is all in the water although we cannot see it; that we can easily detect it* **by tasting a drop of the water.**

3. *Now put some earth into the water, and stir it up in the same way, calling upon the children to tell what they observe.*

The **earth begins to break up** in the water, but **it does not disappear.** It gives the water a muddy appearance. We can see the little particles floating about in the water.

Tell that, because **the little particles of mud float about** *like this, we say they are* **suspended**; *and that if the tumbler is allowed to stand,* **the mud will, after a time, sink to the bottom.** *Stand it aside for examination later on.*

4. *Now fill a large glass bowl with water, and pour some sand into it.*

Elicit that **the sand is neither dissolved nor suspended**; *that it all sinks to the bottom at once and lies there.*

Then show that, by gently stirring the water, the sand is little by little whirled up, and carried round and round.

The particles of sand **float** and **are suspended so long as the water is moving,** but as soon as it ceases to move the sand begins to sink.

5. *Lastly, put some pebbles, large and small, into the bowl with the sand, and stir the water as before.*

Call upon the children to observe that, the sand as before rises and moves with the moving water, but the pebbles still remain at the bottom.

Show that it **requires much more vigorous stirring to move these stones,** *but that at last the moving water is able to move them too, and they are carried along with the particles of sand.*

For the time being **the pebbles are suspended in the water like the sand.**

6. *Now suddenly stop stirring the water, and call upon the children to observe what happens.*

The pebbles **at once sink to the bottom**—the largest

ones first, and then the smaller ones—and as the water begins to move more and more slowly, **the sand also sinks.**

7. Now let us see what we learn from all this. We know that the river, as it flows along, carries with it mud, sand, and stones, **which it washes out of its bed.**

We have learned, too, that the water **flows faster in mid-stream** than at the sides.

8. Now think of what our experiments have shown us, and then try to answer the following questions :—

Why is **the river-bed always deepest in the middle,** and shallower and shallower as we approach the banks ?

Why do we find in one place **a pebbly bottom,** in another **a sandbank,** in another **mud,** in another **deep, hollow pools,** and so on ?

9. *It will be an easy matter to bring this all clearly home to the children now, and show them :—*

(*a*) *That in the* **swiftly-flowing parts** *of the stream we find* **a pebbly bottom ;**

(*b*) *That* **where the flow is more gentle** *there is* **a bed of sand ;** *and*

(*c*) *That* **where the stream moves sluggishly, mud takes the place of sand.**

10. *Point out in connection with this that the tributaries of a river have, as a rule, a much swifter flow than the river itself. Show the reason for this.*

Tell that where this is the case, there is usually **a sandbank** *or* **a little island at the confluence**—*the spot where the tributary runs into the main river. Show this in the model, and explain the reason for it as follows :—*

The swiftly-flowing stream is able to carry away a large amount of sand in its course ; but when it

meets with the slower moving water of the river, it is **suddenly made to move slowly itself,** and then the sand which was suspended in its water **must fall,** just as ours did in the bowl.

III. The Mouth of the River

1. *Elicit next that the part of the river where it joins the sea is called its mouth.*

Remind the children that throughout the whole of its course the river gradually widens. Beginning as a mere thread of water, over which a boy could jump with ease, it becomes at last a wide stream, with ships, perhaps, of all sizes on its waters coming and going continually.

Some rivers are many many miles across at their mouths.

2. **An Estuary.**—*Show the estuary in the model now.*

Point out that this is the **wide mouth of a river.** *It is so wide that* **the sea runs a long way up it at every high tide,** *so that for miles up the river the salt water of the sea mingles with the fresh water which is flowing down.*

We call **a wide river-mouth** of this kind **an estuary;** and because **the tide flows up it** in this way, we call the river itself **a tidal river.**

Remind the children of the wearing-work of the tide on the sea-coast, and point out that the same work is going on along the banks of the estuary, so that **the tidal waves and the flowing stream** *of the river together are continually* **making the mouth wider and wider.**

3. **A Delta.**—*Refer once more to the islands and sandbanks which are sometimes formed at the confluence of the tributary with the main river, and then prepare and show the model of the delta.*

Tell that this represents a river-mouth of another kind. Point out that there is **no wide estuary here,** *but instead*

of that **the river enters the sea by a number of separate mouths.**

Elicit that **the land between these mouths forms a number of islands,** *for the water is all round them.*

4. *Call attention to the peculiar way in which these mouths enter the sea. They have something of* **the shape of an open fan.**

This land at the mouth of a river is known as a **delta,** because in shape it is very much like the Greek letter—delta—Δ.

5. *Explain that the delta is formed in much the same way as the sandbanks and islands are formed at the confluence of the tributary with the main stream.*

The river-bed becomes less and less sloping, or in other words, **more and more level,** as it approaches the sea, and so **the flow of the water becomes slower and slower.** This slowly moving water cannot hold the mud and other matter suspended; hence **it all sinks to the bottom** and forms a deposit there, and this in time **rises higher and higher,** till at last **an island is formed at the river-mouth.**

Summary of the Lesson

1. The middle of the stream flows faster than the sides.
2. The outer bend of a winding river flows faster than the inner bend.
3. **The bed of a river** is the groove or channel in which the river flows.
4. The river, as it flows, tears up its bed, and carries away mud, sand, and stones to a distance.
5. The swifter the river, the more sand, stones, and other materials will it carry away.
6. **The confluence** of a tributary is the place where it joins the main river.
7. **The mouth of a river** is the end of it where it loses itself in the sea.

8. **An estuary** is a very wide river-mouth, up which the tide of the sea flows.

9. **A tidal river** is a river with a long, wide estuary. It is so called because the tide is felt a long way up the river.

10. **A delta** is the land between the mouths of a river. It is formed by mud, sand, and other material washed down by the river.

N.B.—*The usual lesson for recapitulation and memory work, and modelling in clay and sand should follow this.*

Lesson XIV

RIVERS AND LAKES

Prepare and have in readiness a model of a lake, with streams running into and out of it. Have close at hand also the models of the surrounding hills and mountains, which will convert it into a mountain lake.

I. Roadside Pools

Make a rainy day once more the starting-point of the lesson. Lead the children to tell from their own observation that after the rain is over they see, besides the streams of water flowing down the gutter, **puddles of standing** *or* **still water** *in the road itself; and that they know the puddles are still water, because pieces of cork and paper thrown into them do not move.*

1. *Elicit step by step—*

(*a*) That these puddles are always met with **where the ground is uneven;**

(*b*) That they are **fed by little streams** formed from the rain;

(*c*) That, as water must flow down, **the streams run into these hollow places** in the ground, and **fill them up;** and

(*d*) That the water is held in there, and cannot flow away, **till the puddle itself becomes full and overflows.**

2. *Point out that when this happens* **a stream flows out of the puddle,** *because water will always try to reach the lowest level.*

In this way it will be easy to demonstrate that, although the puddle itself is still water, **it is fed by running streams,** *and that there are* **other streams flowing out of it.**

In some places, owing to the nature of the ground, the rain-puddles spread out into **a wide sheet of water,** which we call **a pool.**

A very large pool is called **a pond;** but **puddles, pools, and ponds** are all formed in the same way. They are **fed by running water,** and **streams of running water flow out of them;** but **their own water is still.**

II. A Lake compared with an Island

1. *Uncover the model now, and lead the children to examine and describe it.*

It represents **a large sheet of water with land all round it.** It is like a very large pond. We call it **a lake.**

2. *Compare it with the model of an island, which is land surrounded by water.*

Elicit that it is quite impossible to get away from an island at any point except in a ship or a boat, **because the water surrounds the land everywhere.**

An island is land surrounded by water, and **a lake is water surrounded by land;** but a lake is not the exact opposite of an island.

Show that although we can sail a ship quite round an island,

we could not walk all round the shores of a lake, *because all lakes (except a very few) have water running into them and out of them.*

III. How Lakes are Formed

1. *Refer once more to the pools and puddles in the roadway, and lead the children to tell that the water stands in these puddles,* **because the ground there sinks down into a sort of hole or hollow.**

The water flows into the hollow place and fills it up, but it cannot flow away, because the ground all round it keeps it in.

As more and more water collects in the hollow, some of it at last **flows over the edge,** and **runs away in a stream.**

2. *Tell that many lakes are formed exactly in this way, by streams flowing into some broad, deep hollow, from which the water cannot escape till it reaches the edge of the hollow and overflows.*

Lakes of this kind **are only big pools of water** after all; but they are often so large that **they stretch for hundreds of miles** from one end to the other.

The streams which flow into such lakes, and those which flow out of them, are in nearly all cases **mighty rivers.**

3. *Change the model now, and point out that this lake does not merely stand in a hollow or depression in the ground.*

It is hemmed in on all sides by mountains. The hollow which holds it **is formed by the valleys between the mountains;** but the mountains are grouped so close together that **the valleys,** instead of being broad and open, **are shut in on every side.**

Remind the children that the water which flows in streams down the mountain-sides, whether from springs or directly from

the rain, finds its way at last into the valley. **When the valley between the mountains is broad and open,** *it forms a natural bed or channel, along which this water can flow away towards the sea.* **The flowing water becomes a river.**

4. *Compare this with the water which flows down the sides of mountains, placed as these are in the model. There is* **no outlet** *from this basin-like cavity.* **The water cannot flow away;** *it collects and stands there, and so* **forms a lake instead of a river.**

Point out that, as the water collects, it must after a time find an outlet for itself somewhere round the rim of this basin, and then some of the water overflows, and **a river is formed running out of the lake.**

IV. Blessings of the Rain

1. *Lead the children in the next place to think of the rain as the source of all these streams and sheets of fresh water, which either flow through the land as rivers, or spread themselves out over it in the form of lakes.*

Point out that, with all the abundance of water in the sea, that water is **not fit for drinking purposes,** *either for ourselves or for any other living creatures except those whose home is in the sea; and that besides this* **it would destroy all our plant life.**

2. *Picture the rain falling on the dry, parched soil in the hot summer weather, and call attention to a few of the useful purposes it serves:—*

(*a*) It soaks into the soil, and **dissolves out of it nourishment for the support of the flagging plants,** which but for this would die.

(*b*) This work over, **it drains away from the soil** into ditches and water-courses, along which it flows to join the river, providing on its way **drink for the thirsty flocks and herds** in the meadows.

(*c*) As the river itself winds and curves through the upper part of its course, it is **a clear, sparkling stream,** and **water is pumped out of it and stored up** for the use of the people in the towns.

(*d*) But in all this part of its journey the river is useful in many other ways. **It turns the water-wheels of mills,** and it provides **a waterway for boats and barges and small steamers,** through pleasant meadows, between wooded slopes, past pretty villages, beautiful mansions, and lovely gardens.

(*e*) Lower down **it flows through towns and cities;** but here its waters are **fouled by the filth and refuse** poured into them **from the houses, workshops, and factories** on its banks. It is no longer the clear, sparkling stream it once was, but it is still doing good and useful work, for **it carries this refuse all away** in its onward course to the sea.

(*f*) Lower down still it opens out wider and wider **to form its mouth,** and here the tide flows in from the sea, and the salt water mingles with the water of the outflowing stream to purify it.

3. *Picture the river in this part of its course, with ships of all sorts and sizes continually coming and going, and barges and other craft laden with merchandise, night and day moving on its waters.*

The vessels that come from distant parts of the world bring rich cargoes of food and other useful things for our support, and all kinds of material for our people to make up in the great factories. **They provide work for our workers.**

Those that sail away to distant parts carry back in exchange useful things of all sorts for the people who live there.

Picture the towns at the river-mouths where the ships **load and unload their cargoes.** *Describe the kind of work that goes on there. These towns are called* **seaports,** *or* **seaport towns.**

Summary of the Lesson

1. **A lake** is water surrounded by land.
2. **Lakes** are immense pools of still, or standing water. They are formed by water collecting in the mountain valleys, or in hollows in the basins of rivers.
3. Nearly all lakes have rivers running into them and out of them.
4. The lake is really part of the river, which fills up the hole, and spreads out very wide on both sides.
5. **Seaports** or **seaport towns** are towns at the river-mouths, where ships load and unload their cargoes.

N.B.—*The usual lesson for modelling and recapitulation to follow.*

Lesson XV

RAINLESS DESERTS

The teacher should be provided with good pictures of the camel, a caravan crossing the desert, and the date-palm.

I. Introduction

1. Our lessons have taught us many things about the sea and the ships that sail across it. To-day we are going to learn something about a new kind of ship. It is **the strangest ship** you ever heard of, for it goes along **without either sails or engines,**—it has **no such things as masts,** or **rigging,** or **rudder,** or **anchor,**—and **the men who manage it are not sailors.**

This strange ship is **never seen on the water,** for it is made to travel on the land; **it could not live in the sea.** Let me show you what our new ship is like.

2. *Show the picture of the camel, and ask the children to tell its name.*

This is the ship I mean, but it is not the kind of ship you expected me to show you, for you see it is the picture of **a living animal.** We call it **a camel,** but it has another name. It is also called **the ship of the desert.**

3. Let us see why it is called a ship. Ships carry people and their goods across the sea, **where nothing but a ship could go.** The camel carries its master and his goods across some parts of the land, **where only a camel could go.**

Those parts of the land are called **deserts,** and so the camel has got to be known as **the ship of the desert.** We must find out now what these deserts are like.

II. The Desert compared with the Sea

1. *Picture the open sea, where the sailors may go for weeks together without seeing anything but* **a great waste of water** *all round them, and the sky overhead.*

Then tell that in some parts of the world the land itself is simply **a great waste of sand,** *stretching (like the sea) for thousands of miles across.*

These immense tracts of sand are the **deserts** which we are going to speak about now. The largest of them, which is known as **the Great Desert,** extends for **2500 miles in one direction** and about **1200 miles in the other**

2. *Lead the children to think of the traveller crossing one of these great deserts.*

As far as his eyes could reach he would see **nothing but sand**—*sand everywhere, and the sky above his head.* **He travels across the sand; the sailor across the sea.**

Elicit that the sailor on the pathless sea has nothing to guide him **but the sun, and the stars, and his compass,** *and then compare him with the traveller on this sea of sand.*

He has **no roads** or **paths** of any sort, for the winds are constantly blowing the sand about in every direction. **The sun and the stars are his only guide.**

3. *Picture the level stretch of water over which the ship travels, and then explain that these deserts are* **level tracts of land,** *for they are* **immense plains**—*not of course flat everywhere like the floor of the room, but altogether* **without either hills or mountains.**

In connection with this tell how **the winds heap up the sands in enormous ridges,** *which often reach as much as* 200 *feet and even* 300 *feet in height, and* **look like the swelling waves of the sea.**

4. *Ask the children whether they have ever tried to walk over some loose sand, and lead them to tell how the feet sink in at every step; and then proceed to show that the camel's foot is specially fitted for travelling across the loose, shifting sands of the desert.*

Like the sheep and the cow, the camel walks on its two toes; but these toes are **very broad,** and instead of being encased in a hard, solid hoof, they are furnished with **soft, wide, elastic pads or cushions** underneath. As the animal walks, **the pads spread out,** and so prevent the foot from sinking into the loose sand.

Compare such a foot with the small, hard, solid hoof of the horse. The horse is not fitted for travelling on such ground; his feet would sink into the loose sand.

III. The Intense Heat

1. *Tell and explain that these deserts are always found in the hottest parts of the world.*

The sun scorches like fire overhead, and the

torrents of heat which it pours down are reflected, or thrown back, by the red sands, so that in the glare of noon the air everywhere fairly quivers with the heat.

The sands themselves **look like red-hot waves,** and there is no shelter or shade of any kind, **no rest for eye or limb.**

If the traveller has to cross one of those hollows **between the piled-up ridges of sand,** he finds himself in a suffocating sand-pit, with burning walls on either side, and **scarcely a breath of air stirring.**

2. *Tell of the* **hot, scorching winds** *which sweep across the desert, licking up the loose sand as they go, and* **driving it in a dense cloud before them.**

Picture the travellers—men and camels too—as the sand-cloud comes near. They fall flat on their knees, and bury their faces in the sand, to prevent themselves from breathing the suffocating cloud which passes over them.

IV. No Water

1. *Proceed next to elicit from the class that in burning regions such as this there can be* **little or no moisture,** *for the dry, parched air would* **instantly change it into vapour** *and carry it away.*

Tell that it **never rains there,** *that* **clouds are never seen** *in those skies, that there is* **no such thing as a river,** *or a stream of any kind—***not even a pool of water** *anywhere, and deduce as the result of this that* **no form of animal life**—*not even an insect—is ever found in these deserts.*

2. Plant life is almost as scarce, for nothing will grow in those dry, burning sands, **except a low, coarse, stunted kind of herbage,** which is found in small clumps here and there.

N.B.—*It is a mistake to represent the desert as being entirely destitute of vegetable life. Explain that* **this coarse herbage affords pasture for the camel,** *and that without it the desert would be a closed region altogether even to that animal.*

3. *This will be the time to show how the camel, even in its feeding, is specially fitted to be the ship of the desert.*

Call attention to the **great hump** *on its back. Tell that when the animal is fed well, this hump* **grows bigger and bigger** *from day to day. It consists of* **a mass of flesh and fat,** *and the camel can go without food, or with very little food, for a long time afterwards, because* **it feeds upon the store laid up in this hump.**

Tell too that the camel is a **cud-chewer,** *and that like the cow and the sheep it has* **four stomachs.**

It can store water in the honeycomb cells of its second stomach, and keep it for several days as pure as when it was first drunk.

When the camel is about to start on a journey across the desert, it is fed well for some time, and at the last moment **it is allowed to drink as much water as it can take.** Then with a handful of food now and then from its master, and by **browsing on the coarse herbage** it finds here and there, it is able to make its journey across the sands, where no other animal could live.

V. The Oases

1. *Lead the children next to think of the sea, and the islands large and small peeping up out of it, and then tell that there are* **islands in this great sea of sand.**

These islands in the desert are called **oases.** There are not a great number of them, and as a rule **they are hundreds of miles apart;** but they are of the highest

importance to the people who have to travel across the desert. One of them, which is known as **the Great Oasis, is 120 miles in length.**

2. *Tell that these islands, instead of peeping up out of the sand, always* **lie in hollows below the level of the rest of the desert** *all round.*

These oases are **fertile spots surrounded by burning sands,** just as real islands are surrounded by water. In the oasis, fruits and vegetables of various kinds are grown, but the most important plant of all to be seen there is the **date-palm.**

Show a picture of the tree.

Dates form the chief food of these people of the desert and their camels.

But let us see why the oasis should be fertile while all the surrounding region is nothing but burning sand.

3. *Point out that, as the oasis always lies in a hollow,* **whatever moisture there is beneath those dry, burning sands must drain down** *towards it from all sides.*

It is this **moisture in the soil** of the oasis which makes it **a fertile spot** in the midst of the desert.

Tell that those who travel across the desert make these oases one by one the **stopping-places in their journey,** *where they can rest themselves and their camels, and get a fresh supply of food and water to last them till they reach the next one.*

Summary of the Lesson

1. **Deserts** are dry, parched, sandy plains, hundreds and sometimes even thousands of miles across.
2. The camel is called **the ship of the desert.**
3. There are **no rivers** of any kind—there is not so much as a pool of water in these deserts.

4. There is **no form of animal life** in the deserts; and nothing will grow but a little stunted herbage.

5. **An oasis** is a green, fertile spot in the midst of the desert.

6. The desert is **an immense sea of burning sand**; the oases are like green islands dotted here and there in it.

7. The oases provide resting-places for the travellers who have to cross the deserts. At each one they get a fresh supply of food and water to last them till they reach the next.

THE END

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